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An Adjustable Guide and Spacing Table.

We illustrate herewith a new spacing table for the use of boiler makers, or for other structural iron workers. It is used in connection with a punching or shearing machine, which is placed close to it, and just back of the middle one of the three cabinet columns which support the machine.

Fig. 1 shows the machine as rigged up for curved or segmental work, and Fig. 2 for straight work. The table upon which the work is placed is made in four sections, which are connected together by large joints turned to accurate fits in the lathe, and connected by bolts in such a manner as to allow the sections to be turned upon each other to conform to any desired curve, when, by tightening up the bolts, the table is made rigid. To these sections are attached axes, carrying steel rollers, which run on the guide rails shown, which are also of steel, and, by suitable supports fixed adjustably to the bed, can be made to conform to the curve desired. Pins or studs numbered 2, 3 and 4 are provided on the table, which are adjustable to suit the sheet to be worked upon. The curve can be made in either direction, so that both the curved edges of such a sheet as is represented by the diagram, Fig. 4 (page 2), can be trimmed or the holes punched. Where a series of such sheets as this are to be made, the holes *A* and *B* are first laid off and punched in all the sheets alike; the studs 2 and 4, or 3 and 4, are then adjusted so that the holes punched will go over them, thus insuring that each plate shall be put onto the machine precisely the same as the others, and uniformity secured.

Suitable spacing arrangements are provided for use either on curved or straight work. The change from curved to straight work can be made in less than one hour, and plates from 24″ to 66″ wide and 8 feet long can be handled. It can be used in connection with circular shears if desired, and in punching; about ten times as much work can be done by it as by the old methods, and, of course, in a much superior manner.

The length of the bed is 20 feet; length of table 8 feet. The table is so constructed that it can be made longer at any time by the addition of one or more middle sections. The machine weighs 3,500 pounds, and can be seen in operation at the shops of C. Rittenhouse & Sons, Norristown, Pa., where they are now being built.

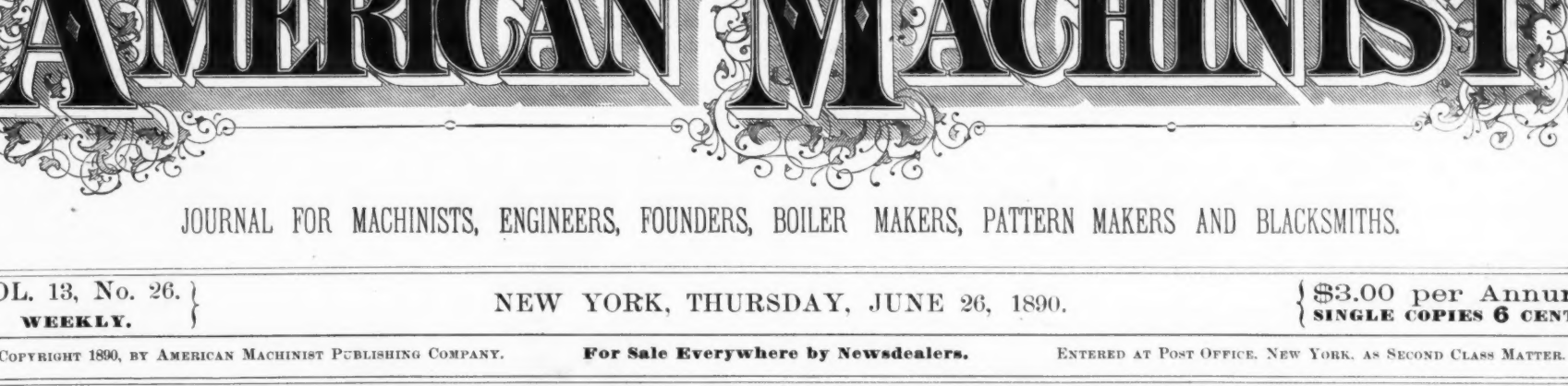
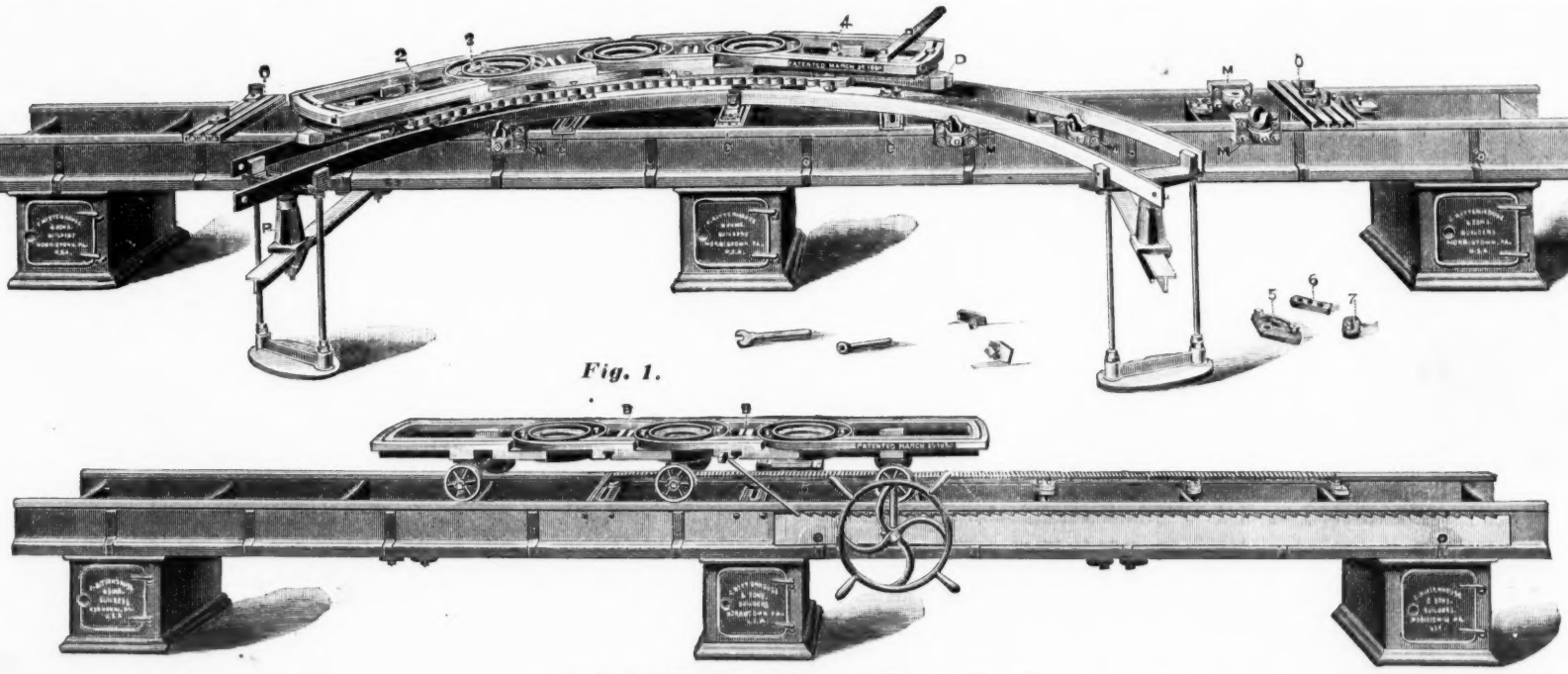


Fig. 1.



ADJUSTABLE GUIDE AND SPACING TABLE.—FIG. 2.

Bids on Three New Ships for the Navy.

On the 10th inst, bids of three new naval vessels were opened at the Navy Department. The largest of these three vessels is a cruiser of 8,100 tons; and is to be partly armored. Length, 350 feet; extreme breadth, 64 feet 2½ inches; depth of hold, 41 feet 3 inches. This vessel belongs to the class of swift cruisers, and is very close to the battle ship, in that she is provided with a moderately heavy armor belt, besides a protective deck. Her speed is expected to be twenty knots, and the engines are to develop 16,000 indicated horse-power. The armor will be about four inches thick, and the protective deck six inches thick. She will be armed with six 8-inch, and twelve 4-inch breech loading rifles. As there are in this country only a few plants capable of building such large crafts, the number of bids were few; but the bids on this vessel, offered by William Cramp & Sons, of Philadelphia, and the Union Iron Works, of San Francisco, were surprisingly close. Each firm offered two bids designated as Class 1 and 2. The Class 1 bids were on the department's plans as a whole; the Class 2 bids were on the contractor's plans. In Class 1, William Cramp & Sons' bid was $3,150,000; and the Union Iron Works' bid was $3,100,000. In Class 2, Cramp & Sons bid $2,985,000; and the Union Iron Works, $3,000,000. The government is to furnish the armor in both cases, excepting the protective deck. The Union Iron Works is therefore the lowest bidder on the department's plans as a whole, while Cramp & Sons are the lowest in Class 2; their bids in this class being also the lowest of all.

The plans submitted by William Cramp & Sons are in the main identical with those provided by the department, the principal modification being in the disposition of the boilers. The department's plans involved placing the boilers in two tiers, three abreast, while Cramps' plans place them in three pairs. This arrangement affords opportunity for two longitudinal bulkheads on each side of the ship below the protective deck, extending the whole length of the boiler and engine space. It removes the boilers several feet further inboard, thus diminishing the danger from ramming, and at the same time affording storage for several hundred tons of coal below the protective deck. There are some minor modifications of the structure of the protective deck to meet the requirements of this boiler plan, and the Cramps propose to subdivide the engine space both longitudinally and transversely, thus making four independent water-tight engine-rooms instead of two, as in the department plan.

In other respects the department's plans and specifications are adopted as a whole. The sizes and weights of the six double-ender boilers are the same, and the engines designed by Engineer-in-chief Melville are adopted, and the general construction of the hull, deck plans and fittings as designed by Chief Naval Constructor Wilson remain unchanged. The battery prescribed by the Bureau of Ordnance is the same; in short, the bid submitted by William Cramp & Sons under Class 2 may be said to be on the department's plans and specifications, modified in some particulars; and the only plans submitted were such tracings as were necessary to show the proposed arrangement of boilers, and consequent minor modifications of structure.

On the other hand, the plans and specifications submitted by the Union Iron Works were numerous and quite elaborate.

The bid of the Risdon Iron Works, of San Francisco, was about $400,000 in excess of the others. The amount authorized by Congress for the construction of this vessel is $3,500,000.

The next vessel in size was designated "Cruiser No. 6." The displacement is 5,480 tons. This cruiser is to have no armor, but is to be provided with a protective deck, four and three-quarter inches thick. Her main batteries consist of two 8-inch and ten 4-inch breech-loading rifles. Her dimensions are: Length, 330 feet; extreme breadth, 53 feet, and depth, 33 feet. Indicated horse-power, 13,500; and the speed is expected to be twenty knots an hour. This cruiser is to be of about the same type as the Baltimore, Philadelphia, Newark and San Francisco, except that her displacement is to be more than a thousand tons greater than any of them.

The Union Iron Works were the only bidders on this cruiser. Their Class 1 bid (on the department's plans) was $1,796,000; and their Class 2 bid (on their own plans) was $1,750,000. The amount authorized by Congress for the construction of this ship is $1,800,000. Deducting the cost of equipment from the amount allowed, the bid of $1,796,000 will probably be considered above the limit, and the one of $1,750,000 will doubtless come within the mark.

The third vessel is a practice ship of 800 tons, a veritable man of-war in miniature, on board of which the future officers of the navy are to receive training as cadets at Annapolis. The Michigan Company—of which Congressman Wheeler is president—bid $245,000; and Samuel L. Moore & Sons Co., of Elizabethport, N. J., bid $250,000. There was some discussion at the department as to whether a firm in which a member of Congress was concerned could be accepted as a bidder for a naval contract. If this question should be decided in the negative, the contract for the practice vessel will either be awarded to Moore & Sons Co., or the vessel will be built at the Brooklyn Navy Yard.

Decay of Boilers.

Many explosions of boilers would not have occurred if closer attention had been given to the deterioration or the boiler caused by the general or local decay of the material. A boiler when new may have a factor of safety of six; but it must be remembered that with the beginning of the life of a boiler decay also begins, and that the original margin of

safety is gradually reduced by the ever progressing decay caused by corrosion; and if this decay is allowed to progress too far, an explosion is sure to take place.

Corrosion does not always attack the surface of steel and iron plates in a uniform manner, hence the decay is more likely to be local than general. This difference in corrosion is probably due to the structural difference in the plates; they are not always perfectly homogeneous, being prevented from becoming so by the nature of the processes of manufacture. For instance, the fibers of iron are welded together by squeezing, hammering and rolling, which sometimes allow the fibers to be separated by thin layers of impurities. The innumerable air and gas cells in steel ingots, more or less perfectly welded together by hammering and rolling, also prevent a perfect homogeneous structure; and it is fair to assume that the imperfect structure of the material is one of the causes of local corrosion. But in steam boilers there are other causes for local decay; for instance, a thin scale tends to protect the plates, but this scale often becomes detached in local places, leaving the clean iron exposed to corrosive action which rapidly progresses. Again, the fibers of the metal may have been loosened by bending, hammering, etc., all of which tends to accelerate corrosion.

Plates are affected in various ways by corrosion; frequently small cavities are formed in the plate, the depth varying from a shallow depression to an actual perforation of the plate. In some cases the cavities lie far apart; in others, they are close together, giving the plate a honeycombed appearance. This phenomenon is called pitting, and may be caused by surface defects due to cinder-spots, etc., but frequently it is due to the intense local action of fatty acids, or other particles of corrosive substances; in some cases the cause of pitting is attributed to the galvanic action of particles of heterogeneous metals.

From the foregoing it appears that, to prevent pitting, good material only should enter into the construction of the boiler, and if pitting then occurs the water should be analyzed, and, if necessary, changed; and greasy substances should not be allowed to enter into the boiler.

Frequently the corrosion forms deep furrows parallel and close to the seams; this phenomenon is called grooving or furrowing. In nearly every case this furrowing occurs under the water line, and in horizontal boilers with lap joints; the grooves are deepest along the horizontal seams. Probably the chief cause for furrowing is a chemical action, because it does not occur with all kinds of water, and it rarely occurs above the water line. But this chemical action is accelerated by a mechanical action which tends to change the form of the shell of the boiler, bending or springing the plates along the seams; but the bending of the plates may break off the incrustation, or even the outside scale of the plate itself, thus continuously exposing a fresh surface of the metal to the chemical action of the water.

The mechanical action may be due to the constantly occurring variation of the pressure, as steam is made or blown off, or it may be produced by the changes of temperature; and if this change of form goes on continually, though ever so slightly, along the same line, the mechanical action of itself must finally produce rupture.

Furrowing is often due to the carelessness of calking, by which the skin of the under plate is cut; careless workmen should not be permitted to use a calking tool.

Furrowing is probably the most dangerous kind of corrosion. In Professor R. H. Thurston's Manual of Steam Boilers we find that of forty explosions of locomotive boilers noted in the British Board of Trade reports, eighteen gave way at the fire-box and twenty at the barrel. Of these twenty, every one was the result of grooving or cracks along the lap of seams, all of which were lap joints.

In order to prevent furrowing, all seams should be placed above the water line whenever it is possible to do so. In plain horizontal cylindrical boilers there should be no trouble in placing the horizontal seams above the water line, and the transverse seams should have welt pieces placed over the joints up to the water line. In fact, all lap joints which cannot be placed over the water line should have inside welt pieces put over them. That welt pieces greatly reduce, and sometimes completely stop furrowing, has been amply demonstrated in locomotive practice.

Pitting in a local part of a boiler is not necessarily an indication that it has also occurred in many other parts, but it does demand an immediate and careful inspection of the boiler, so as to determine the cause and extent of the injury, and steps must be taken to prevent it.

Frequent and careful inspections of the boilers are absolutely necessary; they will pay in the end, and avoid disastrous explosions.

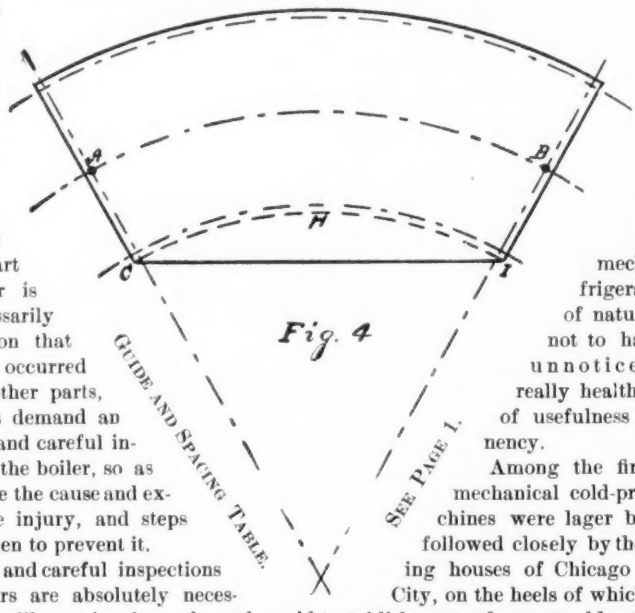


Fig. 4

Mechanical Refrigeration and Ice-making.

BY EDGAR PENNEY.

FIRST PAPER.

Within the past ten years the use of machinery for producing artificial cold has been rapidly developed, and each succeeding year brings it into greater prominence.

The subject, however, considering its importance, has not yet attracted the general attention of the great majority of mechanics and engineers, few of whom have been associated with, or had opportunity or occasion to note the progress in this branch of engineering, and fewer yet have a comprehensive understanding of the principles involved.

Those who profess no knowledge on the subject, but are becoming interested, the writer hopes to benefit.

The steady growth of the business, and the many industries profited by adopting mechanical refrigeration in place of natural ice seems not to have gone on unnoticed, and is a really healthy indication of usefulness and permanency.

Among the first to adopt mechanical cold-producing machines were lager beer brewers, followed closely by the large packing houses of Chicago and Kansas City, on the heels of which we find the establishment of great cold storage warehouses in New York, Philadelphia, Washington and Boston, and to-day it has entirely supplanted other methods of cooling wherever introduced.

One of the most successful adaptations is in the manufacture of ice. Scarcely any town of note south of Mason and Dixon's line is found without an ice factory, from which it will be seen that mechanical refrigerating and ice-making is becoming an important industry.

I propose to tell the readers of the AMERICAN MACHINIST in a few brief articles, written from a practical rather than a theoretical standpoint, the principles, and then the prevailing and best practice of refrigerating engineers, with illustrations.

For the use of the engravings I am indebted to the Frick Company, refrigerating machine builders of Waynesboro, Pa.

Mechanical refrigeration of to-day is produced by the evaporation of a volatile liquid whose boiling point is at least below zero; the lower the better adapted for the purpose, provided the liquid has large capacity for storing and carrying away heat during evaporation.

The liquid in most extensive use is anhydrous ammonia, whose boiling point is about $28\frac{6}{10}°$ Fahr. below zero, with a heat-carrying capacity (latent heat of evaporation) equal to the production of four pounds of ice from water, from and at 32° Fahr.

The method of its use is illustrated in Fig. 1 (simplest apparatus) in which is shown a small open vessel of liquid partly immersed in a larger vessel of water, called a bath. Owing to the low boiling point of the liquid $28\frac{1}{2}°$ below (at atmospheric pressure) the bath of water or brine readily parts with its heat, which causes the liquid to boil; the resulting vapor rapidly carries away the residual heat and lowers the temperature of the water, causing it to freeze upon the sides of the ammonia vessel.

The larger cut, Fig. 1, shows a somewhat more elaborate arrangement, the object of which is to secure control of the rate of boiling (or refrigeration,) and for this purpose a tank charged with the liquid under pressure is connected to a coil submerged in a tank charged with some kind of liquid that will not freeze at low temperature (salt and water).

The office of the evaporating coil is the same as a tube in a steam boiler, and the square feet of surface presented, taken in connection with the range of temperature between the brine and boiling point of ammonia, determines the number of pounds of the liquid that can be evaporated in a given space of time.

The brine, phenomenal as it may appear, is the *fire that boils the ammonia*.

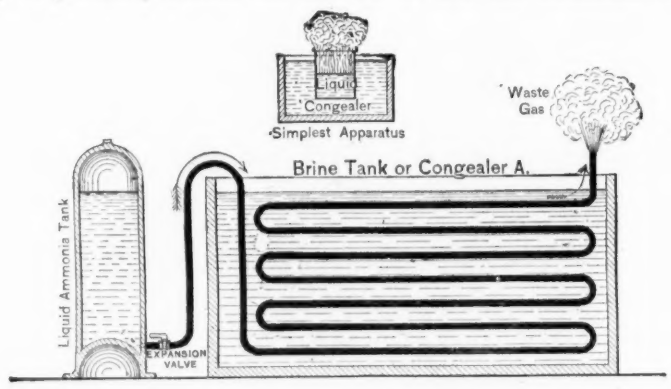
In dealing with the problem of refrigeration, which is a branch of thermo-dynamics, one has to learn that our accepted ideas of heat and cold have to be qualified, and it is difficult to think of anything hot or cold except as to the touch of our hands, but here we find that the terms, "heat" and "cold" are simply relative; that is to say, it matters not the exact point at which the quantities stand as expressed on the thermometric scale so long as one is hot to the other, and this is the case with our bath of brine in the congealer compared to the ammonia liquid.

The cock, or expansion valve, so-called, controls the supply of liquid to the evaporating coils, and is regulated to suit the evaporating capacity of the coils; the gas issuing from the free end of the pipes in this case is wasted in the atmosphere. This is an effective refrigerating apparatus, but a very expensive one to operate; as one pound of liquid will make only four pounds of ice, it will require five hundred pounds to make one ton. As the liquid ammonia costs fifty cents per pound, the cost per ton of ice made by this simple apparatus would be $250.

Now we have to grapple with the problem how to save this evaporated gas and convert it back to a liquid as fast as formed, the apparatus being simple and the operation a continuous one so long as the machinery is running.

Here we have solved the problem in Fig. 2, which shows a complete self-contained apparatus. Retaining the same brine tank as before, we connect the free end of the evaporating coil to a compressor pump, which aspirates the gas as fast as formed in the pipes, and discharges it into another series of coils called a condenser, over the outer surface of which cold water is constantly flowing; the ammonia, under the combined influence of pressure and cold, goes back to the liquid, ready for use again.

Now right here we meet with a point a little difficult for those not posted in physics or thermo-dynamics to understand.



Elemental Refrigerating Apparatus.

FIG 1.

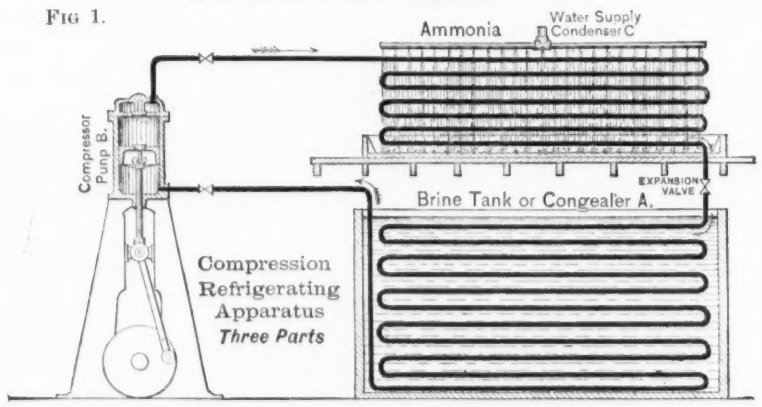


FIG. 2.

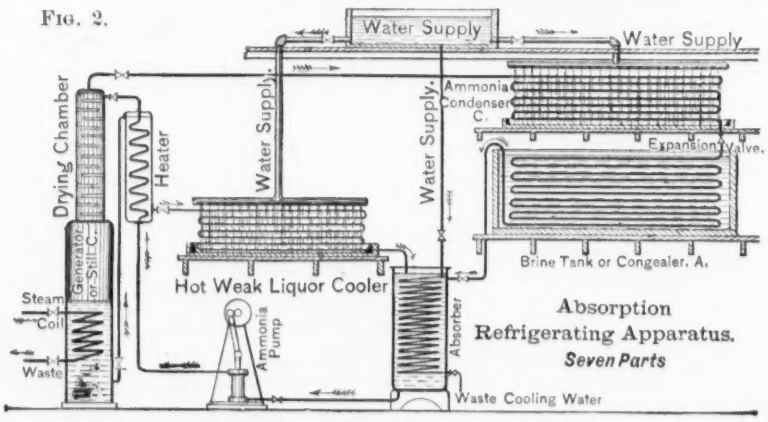


FIG. 3.—MECHANICAL REFRIGERATION AND ICE-MAKING.

Why does the gas go back to the liquid state in this condenser?

The temperature of the condensing water governs the pressure to which the gas must be subjected by the pump in order to condense it, and the application is simply the old well-known law that increase of atmospheric pressure raises the boiling point; and for a given temperature of condensing surfaces it is simply necessary to secure a boiling point, by maintaining a pressure due to the temperature of condensing water.

In practice the artificial atmosphere created by the pump is enough higher than the boiling point, so that gas discharged into the relatively cold condenser will rapidly part with its heat and collapse to the liquid form.

Once charging of this system with liquid is sufficient, the same gas being used over and over.

The simplest and most effective modern refrigerating apparatus then consists of three parts—a *congealer*, *compressor*, *pump* and *condenser*.

Fig. 3 shows another method of compassing the same object, called the absorption system, in which we find the original congealer *A* and condenser *C* from Fig. 2. The capacities and proportions of this part of the plant being precisely the same in each apparatus for equal amounts of work with given temperatures of condensing water. Besides these parts, which it has in common with the mechanical compression system, we find sundry other apparatus. The compressor, or means of creating the artificial atmosphere, is replaced by a retort or still, and, instead of using anhydrous ammonia (dry), a solution of ammonia is used (aqua), about 26 per cent. strong. Owing to the difference in the boiling points of ammonia and water, the steam coil in the still heats the solution, overcoming the affinity of water for the ammonia, and expels the ammonia gas under its own steam or liquefying pressure to the condenser, whence it is expanded into the brine tank, thence flows to an absorber where the evaporated gas is again brought in contact, and re-dissolved or absorbed by the weak liquor which is allowed to run back from the still through the heater and cooler. A large supply of water is needed in this apparatus, as may be expected, not only to condense the gas, but to cool the hot, weak liquor, to a point low enough so it will readily reunite with the gas in the absorber, from whence it is pumped back as strong liquor to the still.

The full details and description of this apparatus, on account of its complication, we have not time or space to dwell upon at length.

Two methods are in use for refrigerating buildings—one called the brine system, shown in Fig. 4, the other, the direct expansion system, shown in Fig. 5.

From what has been already said, we think our readers will have no trouble in understanding the engravings.

The cold brine from the congealer in Fig. 4 is continuously pumped through coils in the rooms to be cooled, and, finding its way back into the brine tank, is constantly recooled and used over and over again.

Fig. 5, direct expansion system, shows the ammonia evaporating coils placed directly in the rooms to be cooled. This method at first sight seems to be the simplest and most effective one. Owing to the danger in case of leakage or breaking of the ammonia system in the store-rooms, and the fact that the brine system is less dangerous, and affords a large reserve of cold brine, which can be circulated when the machinery is stopped for repairs or examination, also that the entire brine system ammonia apparatus is located in the engine-room, being more compact and easily cared for. The direct system has not been generally adopted by refrigerating machine builders.

I will next speak of ice-making.

The Use of Explosives in Bore-holes for Water.

An interesting experiment has just been made at the Herne Bay Water Works Company's pumping station at Ford, from which the principal supply of water is obtained. The site of the station was chosen as being the most likely place in the neighborhood for obtaining a supply of underground water, the geological map indicating the Thanet sand formation, and the depth to the chalk being about 100 ft. below the surface. In the first instance a well was sunk through the sand and a short distance into the chalk, adits being driven in the sand under the company's land, but the resultant supply was of small volume, and only barely sufficient for the purposes of the company; it was therefore decided to bore into the chalk, and a boring commencing 12 in. in diameter and terminating 5¼ in. in diameter was carried to 576 ft. below the surface, nearly piercing the chalk formation; but it yielded little or no water. Under these circumstances it was decided, upon the advice of Messrs. John Taylor & Sons, of 27 Great George street, Westminster, S. W., the company's engineers, to fire a series of heavy charges at regular intervals in the bore-holes from the bottom upwards, in the hope of breaking into one of the numerous fissures which are generally found in the chalk formation, and diminishing the weight of the charges as they approached the surface, to avoid all chance of injury to the surface work. The explosive adopted was "roburite," fired by electricity. The first charge consisted of 27 lbs. of roburite at the bottom of the boring; the second charge weighed 25 lbs., and was lowered to a point 50 ft. above the place where the first was exploded. The second shot was so successful that it was considered unnecessary to proceed further. A large volume of water at once made its appearance at the mouth of the bore-pipe, and has since continued to rise. The additional quantity of water obtained is estimated at about 50,000 gallons per day, which can doubtless be increased if necessary in the future by further explosions.—*Engineering.*

Brine System.

Fig. 4.

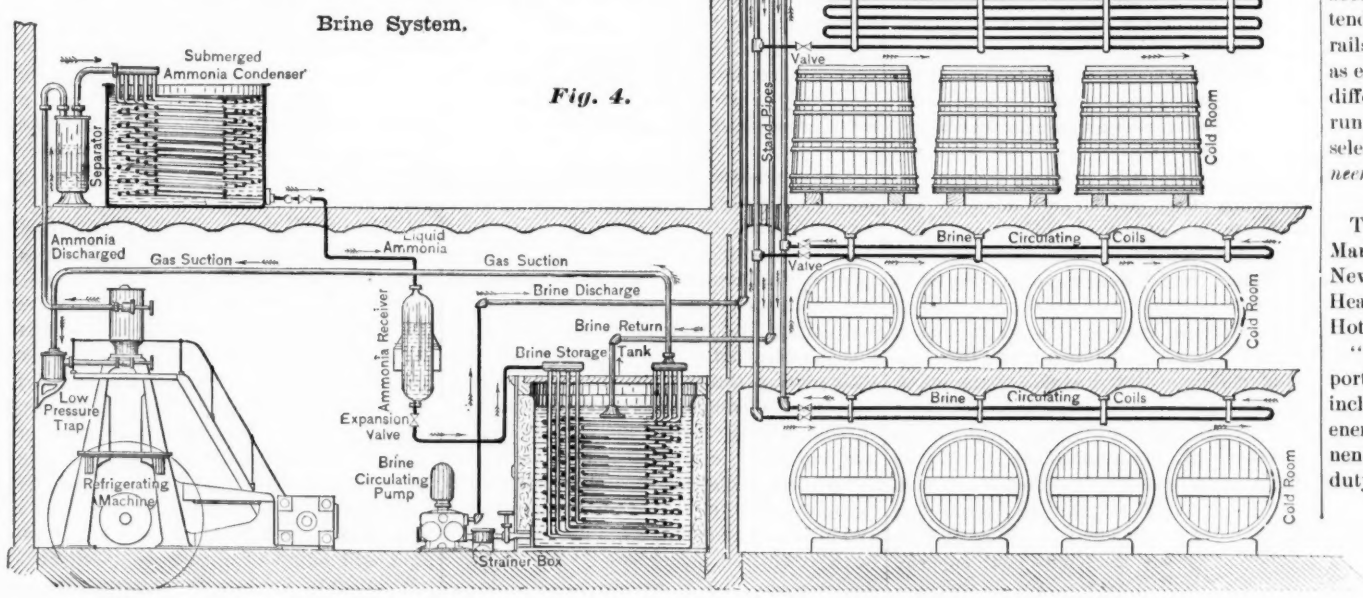
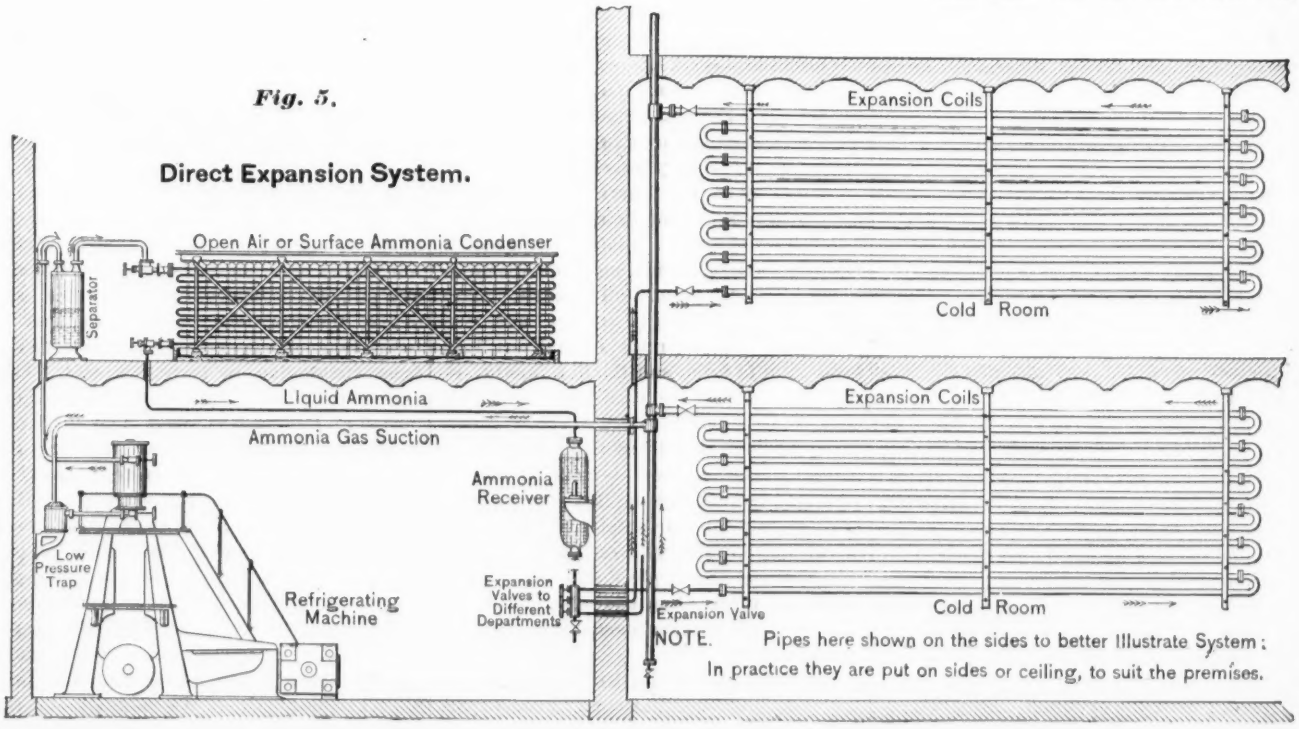


Fig. 5.

Direct Expansion System.


Open Air or Surface Ammonia Condenser
Separator
Liquid Ammonia
Ammonia Gas Suction
Ammonia Receiver
Low Pressure Trap
Refrigerating Machine
Expansion Valves to Different Departments
Expansion Coils
Cold Room
Expansion Valve
NOTE. Pipes here shown on the sides to better Illustrate System; In practice they are put on sides or ceiling, to suit the premises.

The Canadian government is being urged to enlarge the St. Lawrence canals to the same size as the Welland canal. This, it is claimed, would be the means of diverting to Montreal and Quebec a good deal of the import trade of United States seaport towns

The Demand for Heavy Rails.

The demand for steel rails has latterly been of such proportions that the inquiry is often raised as to where the heavy tonnage is going, inasmuch as railroad building is not being very actively prosecuted this year. A very considerable part of the tonnage is undoubtedly to be accounted for by the increased weight of rails purchased this year as compared with former years. It is almost an invariable rule now with all railroads making renewals to order heavier rails than they had previously been using in their tracks. Increasing traffic, greater speed of trains, increased weight of locomotives, greater capacity of freight cars, all demand a better roadbed and a heavier rail. Roads laids with 56-pound rails are taking 60 and 65-pound rails. Those previously using 65 and 67-pound rails are now taking 70 and 80 and even 90-pound rails. We are informed that one of the rail mills, running exclusively on standard rails, has not taken an order this year for rails weighing less than 60 pounds. Not long since the standard weight of rails was 56 pounds per yard, requiring 88 tons per mile of single track. As a 65-pound rail takes a trifle over 100 tons per mile of single track, although but 9 pounds per yard heavier than a 56-pound rail, it is easy to see how the tonnage is being swollen from this cause alone. The increased weight of section is estimated by railmakers at 15 to 20 per cent. above the average of last year's sale of rails. The greatly increased output of individual rail mills, as compared with former years, is also accounted for in considerable part by the tendency of the railroads to order heavier rails. Modern mills handle a 70-pound rail as easily as a 56-pound rail, making a decided difference in tonnage of output in a 24-hour run, or in any other period which may be selected for comparison.—*Locomotive Engineers' Journal.*

The third meeting of the American Boiler Manufacturers' Association will be held in New York, beginning on Tuesday, July 1. Headquarters will be at the Park Avenue Hotel. Secretary Douthett says:

"This meeting will be one of great importance, as questions of a national character, including insurance, will be discussed. All energetic boiler manufacturers on the continent are expected to be present. It is their duty to be on hand, and influence others to attend. In this enlightened age those who have no public spirit cannot succeed, and must make room for others of more advanced views and business tact. No one man knows all, and even the most intelligent can learn from those who know the least; and a gathering, such as the future meeting will be, tends to call forth the matured ideas of men who would remain silent without the inspiration attendant, and gives all a chance to learn from each and each from all."

The Master Mechanics' Meeting.

The twenty-third annual convention of the American Railway Master Mechanics' Association met at Old Point Comfort, Va., June 17th, the first session being called to order at 9.30 by President Briggs.

The divine blessing was invoked by the Rev. George Royal, after which the president introduced Mr. Ingalls, president of the Chesapeake & Ohio and Big Four Railroads, who made an address of welcome.

Disclaiming knowledge of the special subjects which the association had met to consider, he congratulated the members on the importance to which it had attained, said that he considered its deliberations of the utmost importance to railroad interests, and, so far as the Chesapeake & Ohio road was concerned, said it was at the service of the members from the salt sea waves to the waters of the Ohio at Cincinnati, and he hoped they would make all the use of it they possibly could. After speaking of the development which had taken place in the property within the last few years, he referred to the historic associations which clustered about the place of meeting, speaking particularly of the naval battle between the Merrimac and the Union fleet which took place there twenty-eight years ago. This part of his speech was punctuated by the boom of cannons which shook the building, and which seemed to come in at such appropriate periods as to suggest the idea that the guns were fired by Mr. Ingalls himself by quietly touching an electric button. It turned out, however, to be the guns of the U. S. cruiser Baltimore acknowledging the salute of the German corvette Ariadne. At the conclusion of Mr. Ingalls' address a vote of thanks was tendered him, and President Briggs then delivered his annual address, in which he alluded to the prosperity of the country since the last meeting, saying it had been attested by a very large additional railroad mileage, and that it was understood from reliable sources that the mileage for the present year would be still larger. He called attention to the fact that our American railroads have now reached our borders in every direction, and that consequently the future development would be confined to the improvement and building up of our internal country. He thought the master mechanics had for their especial work, not the creation of any new machine for locomotion, but rather the evolution of our present engine, that it may reach the highest efficiency in speed, in power, in durability, and in safety, at the least cost for original construction and for maintenance. He thought it quite probable that, in some sections of the country, other fuel than coal could be successfully used, and invited suggestions from all sections by associate mechanics regarding this matter.

The great diversity in character of country in which our locomotives were required to work, would, he thought, forever prevent anything like national uniformity in locomotives, those which answered perfectly well in a level country with comparatively straight roads, being unsuited to service in a mountainous country. Nevertheless, he thought much had been done in the way of securing uniformity, for which the association deserved the chief credit.

He then paid a high tribute to the great body of engineers and firemen who so ably seconded their efforts in building up the efficiency of the motive power departments, saying they were an army of men larger in numbers, stronger in discipline, richer in intelligence, and higher in bravery than any Alexander could ever boast. He urged the members to encourage these men in their study of their business by the aid of the technical and scientific literature now so abundant, or by any other means within their power. The address closed with a high tribute to the efficiency of the secretary, Mr. Angus Sinclair, for his valuable aid in conducting the affairs of the association.

After a recess of ten minutes the secretary's report was read. It showed a net gain in membership during the past year of forty-one, twenty-four members having been lost during the year by suspension for non-payment of dues, resignation, and death.

The treasurer's report which followed, showed a balance of cash on hand amounting to $1,080.67. A motion was passed fixing the dues at $5 for the coming year.

A resolution offered by Mr. Setchel, and seconded by Mr. Johann, which read as follows, was adopted by a unanimous rising vote:

Resolved, By the American Railway Master Mechanics' Association in convention assembled, that a committee of three members, consisting of J. N. Lauder, John N. Barr and Angus Sinclair, be and are hereby appointed, empowered and directed to confer with the trustees or other proper officers of the Massachusetts School of Technology of Boston, the Cornell University of Ithaca, N. Y., and the Stevens Institute of Technology, and arrange and report a plan at our next annual meeting for the investment of the principal and interest of the Boston Fund of this association in one or more scholarships in one or more of these institutions, and submit the same for the approval of the association. The benefits of said scholarships to be for such time as may be directed by the association, as a prize to the sons of members who shall exhibit the most valuable attainments and skill in the development of locomotive mechanics.

And be it further *Resolved*, That notice is hereby given that a vote will be taken at our twenty-fourth annual meeting to so appropriate said fund.

A previous report by Mr. Setchel, the custodian of the Boston Fund, had shown the total amount of the fund to be at present about $6,678.

During the noon hour, the question, "Is it safe to run a pony truck under the front of fast express engines?" was discussed. Mr. Forney, who propounded the question, seemed inclined to think the pony truck properly designed as safe as any other, and was sustained in this by Messrs. Sprague, Finley, Barnes and Sinclair. Mr. Setchel thought, however, that the greater wear of flanges on the pony truck showed that it had more work to do, and that it would be impossible for most master mechanics to testify before a court that they considered a pony truck as safe as any other.

Below will be found extracts from the reports of committees. The committee appointed to investigate the subject of the "Efficiency of the Link as Compared with other Forms of Valve Motions," embodied in their reports the answers received from a number of master mechanics and superintendents of motive power, sent in response to the inquiries of the committee, and summed up the matter as follows:

"Your committee regret that no report has been received of the performance of the 'Strong' valve gear. The Strong engine has been in service on several roads, and the results obtained in comparison with the link motion would be very interesting.

"Nowhere is the 'survival of the fittest' more pronounced than in railroad practice. The history of valve motions and devices to improve the link motion, and those that were to supersede it (?) would fill volumes. Many have been theoretically correct, and very promising, but, after the crucial test, have resulted in failure; and the link motion remains in almost undisputed possession of the field.

"It has been urged against the link that it is not a scientific or true mechanical motion. This may be true, but the fact remains, that fairly good results are obtained from it; that it will take more punishment in the shape of rough usage and neglect, and cost less to make and repair, than any other valve motion now being experimented with on locomotive engines.

"Your committee are led to believe that valve motions other than the link are experimental, owing to the difficulty of ascertaining data of the results obtained from them, excepting the 'Stevens' motion, of which Mr. Small has sent full report.

"The almighty dollar is always to the front, and, no matter how theoretically or scientifically correct a motion may be, unless it costs less in every way than the link it will not displace it. It frequently happens that the poor results obtained from a locomotive are charged to the valve motion, when the cause may be found in contracted steam-passage pipes, leaky valves or pistons, steam wire drawn through the throttle, and back pressure, caused by contracted exhaust nozzles. It is surprising what a change will be made in the back pressure line of an indicator card by slightly increasing or diminishing the opening in the exhaust nozzle.

"In conclusion, your committee are of the opinion that there has not been brought to their notice a valve motion more efficient for all-around work, and general utility, than a well designed link with large bearing surfaces—assisted in its work by steam passages and pipes of generous dimensions—free from sharp turns and bends—giving the link plenty and hot steam to distribute, and, most important of all, not cripplied at the very end by a contracted exhaust nozzle."

In reference to what is said by the committee regarding the Strong valve gear, it may be proper to say that the reply received by them from Mr. Ross Kells, of the New York, Lake Erie & Western road, and embodied in their report, has, we understand, some bearing on the matter, as his is the road on which it is claimed for that engine, that she has done some of her most remarkable work on runs from Jersey City to Buffalo. Mr. Kells' reply to the inquiries of the committee is as follows:

"We have only made one test of locomotive equipped with a valve motion other than the link, and that test was to determine which of the two designs was the most economical on the basis of coal consumed per ton per 100 miles. We found on this test that our regular link motion locomotives were fully as economical on coal, and much more economical on maintenance of valve gear."

The committee on Brick Arches in Locomotive Fire-boxes made a comprehensive report, from which we extract the following:

"Your committee find it is the unanimous opinion of all those who use bituminous coal and brick arch, that it is most efficient in consuming the various gases composing black smoke, and by impeding and delaying their passage through the tubes, and mingling and subjecting them to the heat of the furnace, greatly lessens the volume ejected and intensifies combustion, and does not in the least check, but rather auguments draught, with the consequent saving of fuel and increased steaming capacity that might be expected from such results. This in particular when used in connection with extension front.

"The statements of several experienced members, based upon actual tests, extending through long periods, also show most conclusively that the brick arch may be used with short front and diamond stack, with excellent results and great economy, when bituminous coal is used as fuel, while but very few replies to our circular give positive data from which even an average per cent. of the saving of fuel could be shown. There remains no room for doubt as to the economy of a properly arranged brick arch in a locomotive fire-box, using bituminous coal as fuel. Some of the replies say the saving is from twenty-five to forty per cent. This assertion is backed by the unanimous opinions of all those using them. The same can be said of its efficiency in decreasing the number of live sparks thrown from stack.

"Your committee have positive proof that the claims for fire along many roads, who formerly used no arch, have been greatly lessened by the use of the arch, even without the extension front, and, when used in connection with the extension front, the throwing of dangerous live sparks was almost entirely avoided, as long as everything was kept in good shape. In addition to the great advantage already mentioned, your committee ascertained the fact beyond dispute that the arch in connection with a well-arranged extension front greatly lessens the throwing of fine cinders and dirt from the stack on the train, thus prolonging the life of car roofs, varnish, paint, etc. Especially is this apparent on passenger trains, and of course adds greatly to the comfort of passengers.

"Your committee fail to find in the large correspondence they have held with practical men who are using the arch, any evidence that one well constructed and properly applied has any seriously damaging effect on the sheets of the fire-box or boiler tubes, but on the contrary much evidence is shown that the tubes are greatly protected at fire-box end, and do not cut away or clog up as fast as when no arch is used, and that as a rule, when an arch has to be removed to clean out or work upon flues that were in good shape when the arch was applied, that the arch will be found to be nearly burned out and to have been in place a reasonably long time, and probably saved many times the cost of its removal and renewing.

* * * * * * *

"There are many points in favor of abandoning the circulating pipes [for supporting the arches] if other satisfactory supports can be arranged. First, the circulating pipe support is attended with more danger from their liability to become clogged or burning thin and bursting, or from blowing out of sheets and scalding firemen or others, even where rigid inspection is made at regular periods. Second, the pipes are more costly to apply and difficult to adjust to position, and, in order to secure a safe and tight fit, great care must be taken in cutting and tapping holes, and threading pipe, sleeve nut, etc., and in the few instances where arch pipes are put in and expanded in position, thinner tubes must be used, and very large holes bored in the sheets opposite ends of tubes, all of which are somewhat objectionable. Third, the pipes are generally more or less in the way of working on boiler tubes, particularly where more than three pipes are used; and if only three pipes are used broken bricks cannot be utilized, which is one of the best features of the pipe support.

"The good points of the pipe support must not be overlooked, however, and among them may be mentioned: First, as a rule, a simpler and consequently cheaper style of brick can be used. Second, if four pipes are used nearly all broken bricks can be utilized, and to those familiar with the shipment of car load lots of ordinary arch bricks this is a big item. Third, if, as claimed by many, that the brick injures the side sheets when allowed to rest close and hard against it, as is generally the case in most other methods of supporting it, the pipes will admit of a suitable space being left at ends of bricks without impairing the rigidity of their support. Fourth, when shops are well equipped and have good system, the circulating pipe support can be put in for much less than it is costing most of our roads at present.

"Your committee find that the first cost of applying brick arch and extension front to locomotives while building can be done in the best manner for about $130 over cost of short front, diamond stack and plain fire-box, and possibly for less than this, while it will cost about the same money to convert an old short front and plain fire-box into brick arch, extension front and straight tack; but, as the old engine should have some credit for difference in cost of diamond stack, if in fair order, as compared with cheap straight stack (a good cast-iron stack of latter type can be made and fitted to smoke-box, and bolted in place with saddle complete for $14), it can be done for less than $130 per engine, if properly handled.

"Your committee find it is the almost unanimous experience of all those using the brick arch and extension front, that its cost of maintenance is much less than the cost of keeping fire-tight and spark-proof any form of diamond stack, or other stack, or spark arrester, with cone and netting and lining exposed directly to the action of coal sparks driven by exhaust, the cutting effect of which is almost as severe as the 'sand blast,' and causes constant and frequent renewals to all exposed parts, while the comparatively gentle suction of the high nozzle of the extension is ample to clear the tubes and deposit the

sparks in the front, but does not cut away the heavy steel wire netting below the nozzles. The sparks in the one instance are caught and driven before the exhaust steam and along with it, while in the other they are sucked or pulled after the successive exhausts, and the sand blast effect is destroyed.

"The data gathered by your committee fail to show any comparative figures of cost of maintaining the two styles of fronts, but the evidence is overwhelmingly in favor of the brick arch and extension front (outside of first cost), and there seems to be no doubt on the part of nearly every one using the arch and extension, that, after an engine has been properly equipped with both, they can be kept much nearer fire-tight at a greatly reduced cost over the diamond stack and short front; in fact, where the extension is properly applied and kept absolutely air-tight below the line of spark accumulation, and a proper adjustment of baffle plates, netting, etc., made and kept, and sparks regularly blown out, they frequently ran from one tire turning to another without any cost of renewing parts, and in many cases instances are shown where plates, nettings and other parts are run in constant service for several years, and where cast-iron stack is used it only has to be renewed in case of accident.

* * * * * * *

"We recommend as the 'best manner of supporting the arch' that arrangement embodying as its principal features—First, Freedom from any danger to those constantly employed about the engine by failure of parts, such as are sometimes attended by the use of circulating pipes. Second, One that can be quickly and cheaply, yet substantially put up and maintained, and that is in a measure protected by the arch from the action of the fire. Third, One that will allow the bricks to be removed and replaced with greatest ease and least possible damage, and that will give easy access to the boiler tubes, tube sheet and crown sheet when bricks are removed; and we think that these several conditions are nearer met by some of the methods shown on blue prints on exhibition in the meeting-room, and known as the "angle iron and stud supports," and we believe that the best features of some of these might be combined and worked into a support that will meet the requirements of the general service. We are not prepared to recommend the abolition of the circulating pipe, but we suggest the serious consideration of a safer and cheaper method for supporting brick arches than is obtained by their use.

"Before closing this report we desire to call attention to the large number of arch bricks broken in transit, and by handling after they are received. This is especially the case where bricks are hauled long distances, and when shapes are flat, long and heavy. It has occurred to us that some suitable means might be adopted to strengthen the brick by having iron rods made up in the moulds in such manner that, should the bricks become cracked or broken through their section, they would be held together and could be utilized, and as soon as exposed to heat in furnace they would fuse together from the effect of accumulated slag, etc.

Artisans Have Neat Dwelling Places in London.

A new and very interesting example of what may be done in the way of supplying fit dwellings for workingmen in crowded places may be found in Spa road, Bermondsey. Although not long, Spa road is the road in Bermondsey. The town hall is there, the public baths are there, the free library is to be there, and at one end of it stand Spa mansions, to which we would direct attention. Unlike the huge, barrack-like structures in Tooley street, this new building is pleasant to look at. On the roadway level there is a row of shops, and above these are what may be called four rows of cottages set atop of each other. Each cottage faces the road, and each row has a frontage protected by light iron railings, and at each corner of the mansions a staircase runs from top to bottom, taking the outward form of a tower. The "mansions" are in suites of four or three rooms each, and each is self-contained. The rooms are light and airy. There is a perfect system of ventilation, and the scheme of the builder has been to afford perfect privacy to each tenant. There is a scullery and offices to each dwelling, a constant water supply and gas, and the kitchens are fitted with good cooking ranges. No tenant will need to stick a big D in the window to summon the dustman, or to mutter a broad d—— if he does not come, for in the scullery there is an opening into a commodious shoot, into which all dirt and refuse may be thrust. With the metal closing to this shoot shut down there is an absolute freedom from anything like smells from drains and other means of fouling the atmosphere. It is pleasant to note the compactness of everything about these dwellings. As we ascend from row to row we find that what is good is good all the way up. The roof itself is used as a drying ground, and we think it will be pleasant for the tenants in the coming summer evenings to use this house top of theirs as a lounging place, for from it the view is very extensive on all sides. Looking north, there are the northern heights of Hampstead and Highgate, and out south can be seen the country about and beyond the Crystal Palace.

Just at the foot of these dwellings is something worse—an old, noisome rookery, in which families are living in the worst of sanitary conditions, and in one way or another paying about as much as the tenants of Spa mansions. The rent of the mansions is about an average of 2s. 6d. per week per room, and that includes the constant supply of water, gas lighting in and out, and conveniences not obtainable in the ordinary habitations of the poor, and often not afforded to families who have pretensions to be among the moderately well-to-do. The owner of these mansions has secured space on which he may build others like them—indeed, one set is now far advanced. He finds it easy to get good tenants, for many of the artisans of Bermondsey earn what they call "good money," and they are not averse to increased chances of comfort at home when they can be obtained, as they can here, within a stone's throw of work. One tenant, for instance, lived out as far as Bow, and had fares to pay going and coming; now his work is only a few minutes' walk away, and he finds rest and comfort close at hand instead of far off.

The builder of these "mansions," Mr. Joseph Down, of Newcross, while thinking of doing work that may prove beneficial, makes no pretense of philanthropy. He sees his way even now to at least a clear 5 per cent. on his investment, and, as he adds the other mansions he has planned, his profits will be proportionately increased. He is fortunate in having found an old well on the land, which gives a plentiful supply of water. It has already given all the water he has needed for his building operations, and when he has had it cleaned out, if he finds the water good for domestic uses, as he believes it will be, he means to supply his mansions with it instead of paying the water company, as he does now. He has laid his pipes, etc., with a view to that, and the water will be pumped to the great tank at the top of the center building, and from there the tenants can draw it when and where they want. In his scheme for completing this work Mr. Down has planned that there shall be a reading and recreation room for the tenants, and all this is to be counted as paid for in the rent charged. There can be no "extras." This means that a skilled artisan with a small family can have a house of three or four rooms, near his work, fitted with perfect sanitary appliances, and affording complete privacy, at from 8s. to 10s. per week. It will be seen that the inclusive nature of the charge makes "rent" a more expansive phrase in this case than it is with those rigid fellows, the economists, from Ricardo downward. Mr. Down's experiment looks as if it would succeed perfectly, and he has evidence, in the number of people who want to come into his Spa mansions, that he has done something that wanted doing. We might say that when the Tower Bridge is completed one end of it will be very near these dwellings, and will so increase the value of the position they occupy. And we should add that a lift is provided for the carriage, up or down, of furniture and all sorts of heavy goods.—*The Pall Mall Gazette.*

Hot Axle-boxes.

BY W. H. BOOTH.

In a works building locomotives it is a very usual practice to cut away the bearing of the axle-box brasses, until the axle bears only on a narrow portion or strip along the crown of the brass, somewhat as in Fig. 1, which shows an exaggerated cross-section of a brass with axle. It is easy to see from this that, whilst the intention is good, namely, to reduce the tendency to heating and seizing by too close a clinging of the box to the axle, room being allowed for the box when heated to close in without closing upon and gripping the axle, yet that, in practice, this system is very faulty; for the bearing being above only, and central, has very little effect in keeping the axle in place; it can roll towards either side to the extent of the clearance, at x or y, and the bearing at the crown soon ceases to fit the axle, becoming of much larger radius, and probably causing overheating. Indeed, seizing of axle-boxes, thus finished, is a common fault.

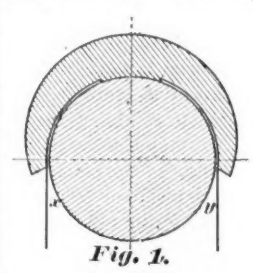


Fig. 1.

In the running shed or roundhouse, when an engine is lifted for hot boxes, a quite different plan is followed. The crown of the brass is removed, and the box bears upon the axle at two strips, as in Fig. 2. These two strips of bearing surface may each have as much surface as the single strip of Fig. 1, and they will, being so far off the vertical center line, have a powerful restraining influence, if the axle tends to roll towards x and y.

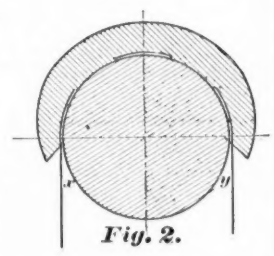


Fig. 2.

Further, the weight of the engine coming upon the axle at points removed from the center, must tend to prevent the box closing in upon the axle, and by this, combined with increased surface and steadiness, the heating and seizing caused by the method of Fig. 1 are overcome. When wear has so far progressed that the axle makes contact again at the crown, it is time again to lift the engine, and re-cut the top clearance. The method of Fig. 1 has further disadvantages too. The ability of the axle to roll towards x or y is liable to cause increased stresses in coupling rods and wrist pins, and, with No. 2 plan, the weight upon the box is sufficient to keep it in place on the axle against the tendency of the steam pressure to roll the axle from under it.

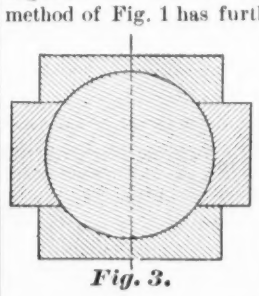


Fig. 3.

With Fig. 1, indeed, there is greater need to keep the brass close up to the axle at the horizontal diameter whilst the danger of doing so is also greater; and in Fig. 2, whilst play can more safely be given at the sides, its necessity is not so pressing. Like the old toast, there is "more luck and less need of it." Except as a preventive against displacement the sides of the brass are useless from the horizontal diameter to the angle of 30° or 40° above it as a means of taking weight, and though usual to speak of the load upon an axle as, say, 170 pounds per square inch of its projected area, this is merely a convenient mode of expression, serving to state that the allowable pressure is not greater than would figure out to this amount nominally. Actually, the projected area is only about three-fourths of this, that is, the area which lies above the angle of 30°, and the true pressure on the projection of actual bearing, will be $170 \times \frac{4}{3} = 226$ pounds per square inch, and to this there is pretty well another 100 pounds to add for the area removed at the crown. Of course, in easing a bearing as shown, a very small amount removed from the brass will relieve the pressure on the region removed, and as wear takes place and the brass beds to the journal, the area of bearing surface constantly enlarges, gradually extending towards the crown. If the easing is carried so far that the remaining bearing area is too small, the heavy pressure on this small area will more quickly wear it away, and by so doing extend the bearing area and check the rapid wear.

The tendency of an axle-box to close upon its keep is well known, hence the slight taper given to the keep or cellar to facilitate its removal. This closing above is proof of the necessity of removing crown pressure, and if by that we can reduce the tendency to come inwards, we can afford to give less play at x and y, and in fact produce a better and more efficient box all round.

For stationary engine work, Fig. 1 upside down is found to act well enough in a four-part box, but then stationary work is different altogether, and the very use of the four-part box with side adjustment (Fig. 3.) is itself sufficient to act as a preventive of rolling on the bottom bearing, and even in stationary work no harm would be done by a slight easing, when new, of the lower brass immediately under the shaft center, whilst to prevent rolling of the shaft, if the side brasses cannot be kept tightly up to the bearing, the lower brass may have a loose fit in the pedestal so as to move with the shaft. Side brasses would act well enough in locomotives, were there only room to apply them; there is not room, however, and therefore the next best plan is to get the steady bearing given by Fig. 2 plan, and avoid the single crown bearing of Fig. 1. On one railroad both plans may be found, No. 1 in new engines, and No. 2 in engines after being lifted in the shed to put to rights the effects of No. 1. As is often said, a man on a railroad, who has not been in the roundhouse, does not know what a locomotive is.

Whether the "factory law" in this State applies to the telephone business or not, we trust the telephone companies will see the wisdom of rescinding their order compelling the girls employed by them to be on duty on Sundays. There is no proper demand for telephone service on the Lord's day, and these companies have no more right to break the Sabbath in a corporate capacity than as individuals. It is a peculiar hardship for the girls to be compelled to work seven days in the week. They are on duty now six days in the week from ten to fourteen hours a day—at least sixty hours a week. That is enough, and more than enough. The companies have no right to exact more.

This order is unnecessary, unchristian, inhumane and injudicious. It should be antagonized by all good men and women. There has been no evidence of any popular demand for it. Before the week closes there will be a great popular uprising against it. —*Mail and Express.*

The high prices of materials which prevailed for some time recently caused a very considerable check to the quantity of work given out, schemes possibly profitable became doubtful with such a great increase in first cost, and business slacked off a good deal. Things are, however, improving again, and projects postponed are being determined and proceeded with. Of this we hear in several directions. There is considerably more inclination all around to do business than existed during the first quarter of this year.—*London Engineer.*

LETTERS FROM PRACTICAL MEN.

Regarding Gear Teeth.

Editor American Machinist:

I have read with interest Mr. Geo. B. Grant's recent articles on gearing, and, while I appreciate all that he has said and done to break down the prejudice so long established against the use of involute teeth, I cannot refrain from noticing some of his statements and conclusions which seem to me questionable or incorrect. I know it is customary in New England to distinguish between circular and diametral pitch simply by using or omitting the inch marks, thus: 2″ *pitch* or 2 *pitch*, meaning in the first instance literally what is written, 2″ pitch, and in the second instance 2 teeth per inch of diameter; but it has always seemed to me unfortunate that so great a difference in meaning should depend upon so slight a difference in expression; and, as Mr. Grant has already shown his independence as a writer and thinker, I would like to submit for his consideration whether it would not be more reasonable to advocate the practice established in other sections of the country, where two teeth per inch of diameter is always written and spoken of as 2 per inch, and the two systems are clearly and sharply defined as the *pitch* and *per inch* systems of gearing. Both systems have their advantages, and both will continue side by side in common use, and for this reason it seems to me important that the distinction between them should be as strongly marked as possible.

I quite agree with Mr. Grant in his objection to the word *epicycloidal*, as applied to the form of teeth, and I am confident that the more correct and convenient word *cycloidal* will ultimately take its place. A change can already be noticed since the criticism was first made a few years ago, and I have no doubt that mechanical terms and expressions may be very generally improved by a little watchfulness and care. But, while I agree with Mr. Grant on many points too numerous to mention, I cannot accept his conclusion that the standard involute tooth of 15° obliquity is the best of all for general use. For an addendum of $\frac{\text{pitch}}{3}$ or $\frac{1}{\text{per in.}}$, the smallest pinion that will run with a rack of 15° obliquity without interference must have approximately 30 teeth; but as this number is too high for a limit, the faces of large wheels and racks must be rounded off to some other shape, as shown in Fig. 40, or the pinion must be cut away, as shown in Fig. 36 of the articles in question.

This rounding off and under-cutting of the teeth destroys a great deal of wearing surface that might be available for many combinations of wheels and pinions when gearing together, and a mongrel system so full of other shapes hardly deserves the name of involute. I have no doubt whatever of the superiority of involute teeth over any other shape, and my reasons are based upon practical as well as upon theoretical considerations; but I want to see an involute system adopted that is worthy of the name; one that is involute through and through, from a 12-toothed pinion to a rack. Mr. Grant himself has already shown that the obliquity of action does not affect the efficiency of involute gearing, except in so far as a very slight difference in pressure on the journals is concerned, and the annoying defects of the standard which he advocates as the best, must be evident to any one who has tried to use it. The great difficulty to be met and overcome in the adoption of a standard system of involute gearing is this bugbear of obliquity, which still seems to linger in the mind of Mr. Grant, in spite of his well-founded conviction that it was not to be feared, and the most radical solution of the problem is in my opinion the best. Make the obliquity of the standard system such that there will be no appreciable interference between a 12-tooth pinion and a rack.

What this obliquity will be depends on the proportion of pitch adopted for the addendum.

Let a = addendum in terms of pitch.

∞ = obliquity.

Then, to avoid interference between a 12-toothed pinion and a rack, we must satisfy the equation:

$$\sin.^2 \infty = \frac{\pi a}{6} = .5236\, a \qquad (1).$$

$$\text{For } a = \tfrac{1}{3},\ \infty = 24^\circ\ 41'.$$

$$\text{For } a = \frac{1}{\text{per in.}},\ \infty = 24^\circ\ 5'.$$

For a = .3, the value adopted by Wm. Sellers & Co., incorporated, we have ∞ = 23° 21′.

I should have no hesitation in using an obliquity of 24° 41′, but this angle may be reduced considerably before the interference becomes as great as the inevitable interference resulting from the use of a limited number of equidistant cutters, and practically it has been found by the company mentioned, with which I am connected, that 20° obliquity is sufficient to give very good results.

For this obliquity the arc of action is longer in pinions and shorter in large wheels than for the 15° system, but more nearly uniform throughout for all combinations of wheels and pinions. It may also be noted that the greater the obliquity the better the distribution of wear on each side of the pitch line, and the greater the freedom in cutting the teeth. On this latter point it is only necessary to mention the drag so common at the pitch line of cycloidal cutters in comparison with the freedom with which an ordinary involute cutter of 15° obliquity will remove the metal before it. Besides all this, the teeth of 20° obliquity are very considerably stronger than "the best of all" referred to, and I feel confident that a reconsideration of these points will lead Mr. Grant to a somewhat different conclusion. On the question of strength I think it quite right to assume, as Mr. Grant has done, that the strength of a tooth is the load it will carry at its end, although when so loaded there are presumably two teeth in gear. Yet a very slight inaccuracy in forming or spacing would be sufficient to throw all the load at the end of a single tooth, and the perfection of gear-cutting machinery has not yet reached such a point as to avoid this possibility. It has, however, so far developed that there is no need of assuming the load to be concentrated at one corner, and even in cast gearing the teeth are generally trimmed to bear across their faces in the better class of shops. I cannot agree, however, with any of the rules suggested for the strength of teeth, assuming, as they do, that all teeth of the same pitch are alike in strength, or so nearly so as to make no material difference. For the cycloidal system in common use, allowing for the largest possible fillets, I have found the rack to be twice as strong as a 12-toothed pinion, and for the involute system of 20° obliquity the difference is a little greater. The rule given by Mr. Grant is a good average, but it covers too wide a range. The factors of safety to be used should depend upon the speed, or rather upon the noise, if it were possible to determine the shock of engaging teeth from such a manifest result. The factor will also depend upon the risk involved to life and property, but for slow and harmless gearing I should not use so high a factor as 10, nor would it pay to do so. I have known a great deal of gearing to work successfully for years on a factor of 3; and, when no serious results can ensue from the breaking of such gears, it does not seem advisable to increase their strength. On the other hand, it may be just as good practice to use 10, 12 or even 15 as the factor of safety where high speed and great risk demand absolute security.

There is still another point in Mr. Grant's letters which struck me with more surprise than anything I have yet referred to, and it seems to me that the question of friction has not been so carefully considered as that of tooth forms, which he has treated so well.

In the AMERICAN MACHINIST for May 15th the difference in the friction of approach and recess is commented upon as "probably due to the difference in the direction of the pressure between the small inequalities to which all friction is due." This is followed by an illustration, from which it appears that during recess the inequalities are supposed to lift over each other like a ratchet and pawl, while during approach they "tend to jam together." Further on we find: "It has been satisfactorily determined that the loss is greater during the approaching than during the receding action. This is not shown by the formula, but it may be laid to a variation in the co-efficient of friction."

It is undoubtedly true that the friction of approach is greater than that of recess, but there is no occasion for the slightest speculation as to the cause of that difference, nor is there any ground for supposing that the difference may be laid to a variation in the co-efficient of friction.

Let E and D, Fig. 1, be the centers of two equal gears engaging at the point b, and let p be the pitch point on the line of centers $E\,D$. The line $b\,P$, normal to the faces in contact at b, would be the direction of pressure between the two wheels in contact if there was no friction, but during approach when E is driving D, the direction of pressure between the wheels deviates from the normal $b\,P$ in the direction $b\,a$ by the angle of friction $a\,b\,P$. Similarly during recess, when D is driving E, the direction of pressure is represented by $b\,c$ at the same angle to $b\,P$. The angle of friction is, of course, exaggerated for the sake of clearness, but it is evident that when D is driven, the resultant force of pressure and friction has to drive it at the short radius $D\,a$ from the center D, while, when E is driven, the resultant force acts upon E at the much longer radius $E\,c$. Letting F equal normal pressure at b required to overcome a given resistance in D, and G equal normal pressure at b required to overcome the same resistance in E, we have, assuming also that the friction is proportional to the pressure, for the point b

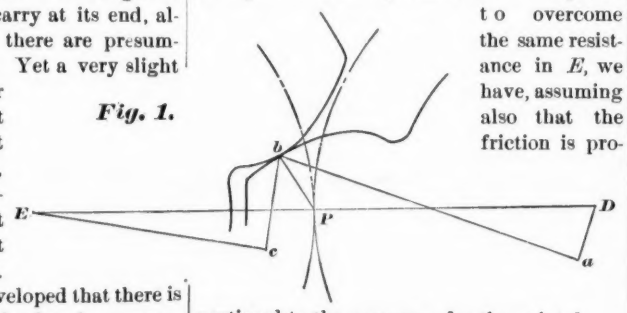


Fig. 1.

$$\frac{F}{G} = \frac{E\,c}{D\,a} = \frac{\text{friction of approach}}{\text{friction of recess}}.$$

The action may be regarded as somewhat like that of a friction catch, but there is evidently no occasion to assume any variation in the co-efficient of friction to account for the phenomenon.

I have mentioned 20° as a good angle of obliquity for a system of involute gearing in which the addendum is .3 pitch, but for the larger values preferred by Mr. Grant and others, I think it would be better to go beyond this limit, making the obliquity about 22°, or, if preferred, to make the base circle .93 or .92 of the diameter of the pitch circle.

WILFRED LEWIS.

Dimensions on Drawings.

Editor American Machinist:

The remarks of "A Mechanic" in your recent issue, on the above subject, were pertinent, as the neglect of putting all dimensions on drawings is prevalent in many shops, in spite of the protests of foremen and men; true, in some cases this is an oversight, and is excusable, but in the many cases it is due to carelessness, ignorance, or an utter disregard of the employer's interest, which is inexcusable. Those who speak from experience know how aggravating it is to a foreman to have an employe stop his machine, and either wait for the foreman to come around or follow him to the other end of the shop, to ask the dimension of some part that has been omitted by the draftsman, and necessitates going to the office, or scaling the drawing, only to find that (as is too often the case) it does not agree with the figures given to parts which belong to the same machine, or possibly on some other drawing not yet sent into the shop. And the error is frequently not detected until the parts are assembled, with the result that the work is delayed, the foreman loses patience, and the draftsman is profuse in explanations of how the error was made. Then the proprietors *pay the cost.*

If proprietors were cognizant of this carelessness on the part of draftsmen, they could more readily account for the figures in the loss column of "profit and loss," and would speedily insert an ad. in the want columns of the AMERICAN MACHINIST.

It was years of experience as mechanic and foreman, under just such circumstances as above, that prompted the writer to adopt the following method of making working drawings (particularly details), always observing these rules.

1st. Select only good white paper and best ink. 2d. Make as many views as necessary to show piece plainly with the least possible number of dotted lines. 3d. Make all lines plain; use heavy shade lines where necessary; line all sections, and do as little so-called shading as possible. 4th. On original or white drawings, give all centers, center lines, and radii of curves in red ink, and dimension lines in blue. 5th. Verify all dimensions (even if the day is hot or you are tired) before sending drawings into the shop. 6th. Remember that the foremen of the different departments do not know your "ideas," unless expressed on the drawing, or by written or verbal instructions. 7th. Remember that neither the men nor foremen carry a bevel protractor, proportional dividers, irregular curve, triangle and tee square in their pockets, and few know anything about sines, cosines, etc. 8th. Remember the machinist is not the blacksmith, boiler maker, or pattern maker, or *vice versa*. It would be well for many draftsmen to commit the above to memory, or "paste it in their hats," and thus save confusion, time, temper and money.

The following method was used four years by the writer, and thus far no improvement has suggested itself, and has been a signal success in the shops, facilitating work, and removing all possibility of a misunderstanding of drawings, and very materially reducing the scrap pile.

After selecting the kind of paper wanted, make a sufficient number of views to show *plainly what you want* without necessitating a foolscap sheet to explain your drawing; make the lines plain, following rules four and five, giving *all* dimensions and radii of curves, and if irregular curves, draw a line parallel to your center line, then erect perpendicular lines at intervals (the distance apart being governed by the irregularity of the curve), on these mark the distances, so your pattern maker can use a flexible rule in transferring the curves. The drawing inked, center lines, dimensions, etc., being marked and *verified*, tack the drawing on a board, and cover with a cheap grade of tracing paper (which is far superior to glass), then send it on its merit to the pattern or blacksmith shop, and you will not be pestered with questions from the pattern maker, blacksmith or foundryman, but can use your time better, and, like the barbers, call out "Next."

Should there be any alterations or corrections necessary during the progress of pattern making or forging, make a note of it *on the drawing* in red ink. After the patterns are completed, or the forging made, take your drawings and make your tracings for the machinist, putting only *such center lines and dimensions as are essential* for the machinist to complete the work; this will obviate the unnecessary care and work by the machinist, in places where it is unnecessary, as in cases mentioned by "A Mechanic," and will not confound the machinist work with that of the pattern maker or blacksmith.

For parts on which finish is to be allowed by pattern maker or blacksmith use the symbol ⊙. For finish by machinist where no dimensions are required use ⊃. For a polish where called for use x. For reamed holes, r. The above rules and method of making drawings has been used because it means dollars and cents to the employer by the production of more and better work, reduces the work of the foreman, and keeps the men in better humor; for none of us like to spoil a piece of work, even if it is not our fault.

W. B. KURTZ.

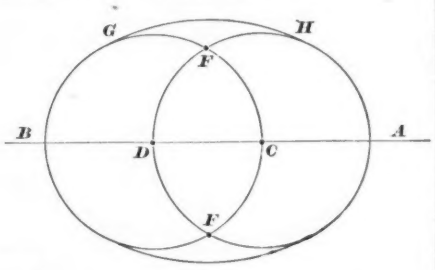
To Draw an Ellipse.

Editor American Machinist:

Question 187, May 22d, asks for a machine to draw an ellipse for manholes, etc.

They can be drawn with an ordinary compass as follows:

Draw a straight line, as *A B*. On this line lay off the long diameter of the ellipse, and divide it into three equal parts.



With one of these parts as radius, and *C* for center, draw one of the circles, and with *D* as center, and the same radius, draw the other.

With *E* as center, and *E G* as radius, draw the arc *G H*, tangent to the former circles, and with the same radius, and *F* for center, draw the lower arc, and the outside lines will be the ellipse.

The writer once saw a manhole that had a straight line from *G* to *H* instead of an arc. This is unusual. W. E. CRANE.

Pumping Water an Abnormal Height.

Editor American Machinist:

When I first wrote and mentioned this raising water through a height of forty feet, I did not expect the subject would have raised so much discussion. Of all the letters which have appeared in discussion, one only, I believe, or two, unreservedly admit the possibility of it; and I was interested in the description of the method by compressed air, which, I take it, acts by an alternation of air and plugs of water. Since first writing no opportunity has been afforded me of further investigation. The locality is 200 miles away from London, and away amongst the hills, but I shall watch the opportunity if it arises. In reply to those doubters who think a pump would fail to work under the supposition advanced by one, in explanation I ought to state—if I did not do so—that the action is not produced by a small reciprocating pump, but by the condenser of a large engine (50-inch diameter cylinder). There is a continual vacuum of over 12 pounds, and so the upward flow of the water column is constant, and not intermittent, as it would be were it caused by a small pump, and there is, therefore, no time allowed for the air or gas to coalesce; it rises as it is generated in the body of the ascending column, and though, as I was careful to explain, I could not state from personal knowledge that the thing was a fact, there seems no good reason for doubting its possibility, and my informant was perfectly aware of the peculiarity of the occurrence, and had had an independent measurement made by the maker of the vacuum gauge with the same result.

Reference to a table of solubility of gases in water at 50° temperature shows that one volume of water will dissolve 1.1847 volumes of carbonic acid at ordinary atmospheric pressure, and no less than 3.5858 volumes of hydrogen sulphide, and 812.8 volumes of ammonia. At reduced pressure much of the dissolved gases are set free, and as the water was from old coal workings, and described as of very unpleasant smell, there seems a chance to believe that the evil smell may be due to hydrogen sulphide, or even to ammonia also, which is so very soluble. As the solubility at all *pressures* is represented by the same volumetric coefficient, it follows that under a 12-pound vacuum there will be liberated four-fifths of the original amount dissolved, or a mean from base of column to head of say two-fifths, and, when liberated, each volume will occupy a mean of two and a half times its volume at atmospheric pressure. Therefore for each original dissolved volume of gas in water, a 12-pound vacuum acting on a vertical column of the water will result in the liberation in the column of gas which will occupy $\frac{2}{5} \times 2\frac{1}{2} = \frac{5}{5}$ths of a volume. In other words, each cubic foot of water which has dissolved only one-third of a cubic foot of carbonic acid (not 1.1847, as it can do) will be expanded to $1\frac{1}{3}$ cubic feet of mixed gas bubbles and water, and a 12-pound "vacuum" would hold up a 35-foot column, whilst a much less proportionate fraction of saturation with hydrogen sulphide would produce the same results.

That such a result is not often met with is probably due to the fact that, with an ordinary reciprocating pump, the air has an opportunity to collect in the upper part of the pipe, and the pump bucket loses its water, and begins to pump out gas, and so speedily produces a column of water beneath it, disaerated and weighing full weight, or 33 or 34 feet per atmosphere only. Now in the case mentioned to me, the rising column would be, perhaps, four inches only—the injection pipe—and the pump, the constant pull of a big condenser cleared of air by a large air pump. If a fact, as I feel bound yet to believe, this matter of constant draught will explain why the rising column does not separate into air and water, the latter solid. Time is required for the separation, and, as Handy Andy found, a liberated soda water bottle will become emptied by the escaping gas carrying the water also with it, instead of separating quietly. In the rising column, too, fresh gas bubbles are freed with every inch of ascent. It is not as though so much gas were admitted once and for all at the base of the column.

There is a critical pressure for each degree of solubility, and a continuous liberation of gas going on all the way up the pipe; nor does it appear even that a very high degree of gaseous saturation is necessary for the result claimed—40 feet. One-half volume of CO_2 per volume of water would secure this result, or a less than 50 per cent. saturation.

WM. H. BOOTH.

Gear Teeth.

Editor American Machinist:

Having read with care articles appearing in the AMERICAN MACHINIST from the pen of G. B. Grant relating to gear teeth, I want to criticize some items which he claims; at the same time, admitting that he has furnished other items of value on that subject.

First, in his articles he claims that the tooth known to the mechanical world as the "involute" is the most correctly formed tooth, theoretically and practically. That there is a degree of incorrectness in this claim for fine working gear wheels and teeth the writer has learned from years of experience in constructing, using and observing the action of teeth. I know of parties who built a metal planer, and fitted it out with a train of wheels having involute teeth, cut with the Brown & Sharpe cutters. As the parties were engaged in the construction of first-class machine tools, it was their design that the new planer should "plane smooth." It was absolutely necessary for it to "plane smooth" in order to do what they built it for. When it was started up it did not meet the requirements. After proper consideration it was decided that the cause of the trouble was in the use of the involute tooth; and, without molesting any other part or parts of the planer, the builders purchased another set of cutters of Brown & Sharpe, of the epicycloidal form of tooth, and with them cut a new train of wheels, and mounted them in place of the involute toothed wheels. When the planer was started up again it worked to a charm. Where was the difficulty with the first train of wheels, and rack? undoubtedly in the want of ease of action of the teeth, on the approach of tooth with tooth, especially that of the driving wheel and rack, on the platen of the planer.

Again. Of all of the multitude of lathes fitted with back gears, many have the epicycloid form of teeth; others have the involute. Now invariably the epicycloid runs the finest, and when fitted up correctly will run still in comparison to the involute now in use, which Mr. Grant clearly delineates in his articles.

My attention was once called to notice a back-geared universal milling machine, in use in the tool-room of a first-class firm who build machine tools. When asked to tell why the wheels made so much noise, the first item of discovery was that the teeth were involute in form. The milling machine was built by a firm whose name for doing fine work is first-class, and honestly so too. The milling machine was not an aged one by any means; had been used exclusively in the tool-room of the firm, and was not worn out by any means. The trouble was in the tooth, especially in the nature of the action of the pinions with the wheels when approaching in action.

Second. This brings us to note that one source of evil with the present form of the involute tooth is that the radius of the curvature of the face and flank of teeth is too large (especially so in wheels which have a greater number of teeth than 24). The writer has found that the following modification of the present involute system has worked much better. In a pitch of wheels "one to the inch" teeth, from twelve teeth to a rack inclusive, make the radius of the curvature of the teeth from $1\frac{1}{4}$" to 4", *i. e.*, $1\frac{1}{4}$" for twelve teeth, and 4" for rack, and wheels between having proper radius of tooth curve inside of the above limits. Instances could be cited where the common 30 degree rack involute system had been supplanted by the curved tooth of the above system with very much satisfaction, both in ease of action and keeping in shape as they wore. Of course the above curvature of teeth must be properly located, which I will give in a future article.

Third. Some theorists have improperly entertained the theory that the teeth of wheels must have sufficient elongation of the face curve, so that when they enter into conjunction at an angle to each other they must drive (or fit as closely) as the teeth which are fully in action—*i. e.*, center of the wheels; whereas in easy-working gear teeth, that form which places the tooth well into the space before it begins to drive has two exceedingly desirable points of action, namely, "rolling contact," and ease of action under a load; consequently they will not wear out of shape as readily as the more sliding in action tooth; the crowning tooth imitates to some extent the movement of lever over a well-rounded and uninterrupted bearing.

FRANCIS W. CLOUGH.

Slow or Quick Moving Mechanics—Wants to Know.

Editor American Machinist:

I think that T. A. Pandie is about right when he says that a workman's movements are to a great extent governed by the speed of the machinery he is surrounded by. I have frequently noticed it; there is quite a contrast in the movements of a man who runs a 14-inch lathe on light work, and the man who runs the big 12-foot boring mill, seldom turning anything less than 8 feet in diameter, and yet if the latter is put onto a small lathe he will fly around as lively as the next one.

Some time when "Tool-room" gets time, I wish he would tell us his method of making the small end mills mentioned by him in your issue of the 15th inst.

I wonder if some of your readers can tell us of an easy way to make a measuring instrument something on the same principle as a micrometer caliper, with a capacity of about three inches—something that could be made in an ordinary machine shop, containing, amongst other good things, a first-class engine lathe; it need not measure to thousandths of an inch, but divide to thirty-seconds, or even sixteenths.

CHARLES A. TRASK.

Designing Countershafts.

Editor American Machinist:

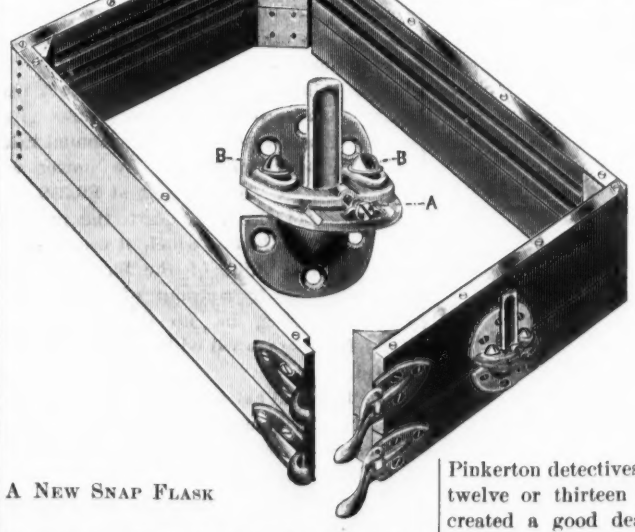
The writer recently had occasion to erect several countershafts, and, although made by one of the best known machine companies in the country, they were of poor design, to say the least. The counters in question have three pulleys, two loose and one tight, each with 6-inch face; on these pulleys run two three-inch belts, one plain and one twist. From floor to ceiling the height is ten feet. The shipper handles are about six feet long; from fulcrum to shipper rod is about nine inches. To properly ship the belt requires a travel of the rod of about $3\frac{1}{4}$ inches; to get this it is necessary to move the handle of the shipper some 28 inches. This brings the handles in such a position that by their own weight they work down until they are plumb, throwing the belts on the loose pulleys. It is needless for me to say more; it is a thing that is easily remedied, but the time to do it is when designing, and for that reason, with your consent, through the columns of the AMERICAN MACHINIST I will present this article as a gentle reminder for the designer of countershafts.

J. L. B., JR.

A New Snap Flask.

The illustration presented herewith is of a new snap flask, which is regularly made for the market by E. C. Stearns & Co., Syracuse, N. Y., they believing that, by fitting up for their manufacture, they can furnish a better flask than is usually made for use in foundries, and at considerably less cost. The large V-shaped pins with corresponding bearings insure a level fit of the cope, and get rid of much of the trouble experienced with difficult patterns.

An enlarged view of the pins and guides which are at each end of the flasks, is shown by the central illustration. The brass screw *A* is used to take up any looseness or wear in the pins, while the clasping screws *B* hold the parts together. The flasks are made of white wood, which is light in weight, yet stiff and strong, and are bound with iron. Where it is preferred they will be made with metal corner irons put on outside, instead of the corner blocks inside, as shown in the engraving. Metal furnishings only will be furnished where parties prefer to put up their own flasks. They are made in twenty-eight different sizes and proportions, from 9" to 13" wide and 13" to 19" long, with 2" nowel and 3" cope.



A NEW SNAP FLASK

Four or five years ago, during the coal handlers' strike in Jersey City, one of the Pinkerton detectives—so-called—killed a boy twelve or thirteen years of age. The act created a good deal of indignation at the time, and since then not only workingmen, but others, have been quietly working for a law that should prohibit the employment by corporations of an irresponsible armed foreign force in the State to settle labor disputes. The outcome of this agitation is a law making it a misdemeanor for any official qualified to appoint special peace officers to appoint as such any but citizens of the State. The law also provides heavy punishment for any person not a citizen who shall act as a peace officer in New Jersey.

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NEW YORK, JUNE 26, 1890.

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"Rating" of Machinery.

A question which for some time has been agitating the minds of owners and users of machinery in Great Britain is that of the taxation of machinery—a question in which the Institution of Mechanical Engineers have taken an active interest.

For the past fifty years there has been in force in England a law which was intended to exempt stocks in trade and personal property from liability to local assessments. Though there can be no reasonable doubt as to the intention of Parliament to make this exemption apply to all personal property, the act has been annulled so far as machinery is concerned, by the efforts of persons who imagined their interests to be promoted by the taxation of machinery, aided by decisions of the courts.

The method of accomplishing this has been by setting up the claim that the presence of machinery in a manufacturing building enhanced the value of the building, which was accordingly rated in proportion to this increased value. Of course this amounts to a direct tax upon the machinery itself, notwithstanding it is apparently levied upon the real estate, and as farming and all other machinery not fixed in buildings, as well as all other personal property used in trade was exempt, the owners and users of machinery in building have very justly felt that they had a grievance which they have sought to remedy by securing the passage of a law directly bearing upon the matter.

Some of the taxes laid upon real estate in Great Britain are collected directly from the tenant; but whether so collected, or from the landlord, it is of course the tenant who actually pays all of them; and where this tenant happens to be a manufacturer, using large quantities of valuable machinery in his business, the burden thus laid upon him becomes exceedingly heavy, and he can only shift it upon the shoulders of his customers, so far as competition will allow him to do so. If the competition of the British manufacturer were confined to British manufactures, he would probably pay the tax without much grumbling, since all his competitors being in the same boat, he would simply increase his prices to cover the increased cost of production caused by the tax, with a profit besides, which the final consumer of the goods would have to pay.

But the British manufacturer competes with the manufacturers of the world, and those in other countries can hardly be expected, when thrown into competition with him, to fix their prices with regard to the taxes he may have to pay; if they can undersell him on account of these taxes, they will, of course, do it, and since the prosperity of Great Britain depends so much upon exports of things produced by machinery, there is no other course open, but to make an effort to get the burden removed.

That this burden is in some cases very heavy, may be seen from the figures given in the "Chard case," where the annual value of a factory with its motive power was $1,450, but it was assessed at $6,350, the increase of $4,900, being due to the presence of a lot of lace looms, which it was claimed enhanced the value of the factory. That such a tax is in restraint of trade, there can, of course, be no doubt, and the effort for its removal will doubtless be successful.

The idea that extra burdens of taxation can be laid upon the use of machinery, and that the users of that machinery must bear it alone, is a mistaken one. If competition is confined to those upon whom the burden is laid, they will surely shift that burden onto the shoulders of the consumer of the manufactured goods, while if competition is not so restricted, general business and trade will inevitably suffer.

If it would be a desirable thing to go back to the employment of brute force in supplying our wants, unaided by tools or machinery, then it would be a good thing to pile up the burden of taxation upon tools and machinery; but if machinery is a good and desirable thing, then the fewer burdens are imposed upon its ownership and use the better; not only for the owner and user, but for everybody else as well.

One of the latest applications of electricity that has been reported is to what is called a locomotive telephone. It was tested recently on the B. & O. Railroad, and is said to have worked very satisfactorily. The apparatus is described as consisting of a single iron bar laid between the tracks, through which a current of electricity is passed. A brush is fixed upon the engine, which is at all times in contact with the bar, and when two engines approaching each other get within a mile or more apart, bells ring in the cabs, and after the engines have been stopped the engineers can make use of the telephone in abusing each other for being "on my time." This may be a very good thing, but if the uncertainties of the ordinary telephone are any criterion by which to judge, those bells will be very likely to ring at wrong times and give false alarms until they are paid no more attention to than was the boy who cried wolf when there was no wolf. Or they may fail altogether, and allow the trains to approach close enough to enable the engineers to exchange sulphurous remarks without the aid of the telephone. We pin our faith to the block signal.

A unique method of settling a strike was adopted by the proprietors and employes of the National Tube Works at Pittsburgh a short time ago, at the suggestion of the manager, Mr. E. C. Converse, who expressed his willingness to raise wages to the figures paid by any concern in the country engaged in the same line of business. A committee was appointed, who spent three weeks in investigating the matter, making a tour of the different works. In only one establishment did they find higher rates of wages than those paid by the National Tube Works, and that in only a few departments. The difference was very small, and wages have been raised in those departments according to agreement. The expenses of the investigation were paid by the company, which does a large business, and employs about four thousand men.

It sometimes happens that questions beside the rate of wages paid in other shops are to be considered in the settlement of such difficulties, but where such a fair, reasonable and common-sense method as this is pursued, it is safe to predict that the risk of serious trouble will be very small indeed.

Whether or not the Contract Labor law is a good one, it should be rigidly enforced as long as it is a law. If it is bad, as some assert, its rigid enforcement is the best way in the world to secure its repeal. We believe, however, that disinterested people generally believe that the law is necessary for the protection of American workingmen. Employers of labor are protected by high tariff, and it is difficult to see why they should buy their labor in the open markets of Europe. Several cases have occurred lately where laborers coming here under contract have been returned. That is as it should be. A complete enforcement of the law, with all its penalties, will soon demonstrate whether the people want it or not.

Literary Notes.

We have received from Mr. James M. Swank, General Manager of the American Iron and Steel Association, a copy of the Annual Statistical Report of the association, giving complete statistics of the production and prices of all the principal iron and steel products, iron ore and coal, construction of railroads, and iron and steel ships in the United States for 1889 and previous years. Also complete statistics of the imports and exports of iron and steel, and imports of iron ore for the same period.

Statistics are also given regarding the iron and steel and coal mining industries of nearly all foreign countries. All the statistics gathered by the association since its organization have been condensed into tabulated statements for this report, some of the statistics going back to the beginning of the present century. To any one interested in the iron or steel industries, or industries connected with them, this report will, of course, prove interesting and valuable. It can be had by addressing the association at 261 South 4th street, Philadelphia, Pa. Price, $3.

REFLECTIONS OF THE MOTIVE POWER OF HEAT, AND ON MACHINES FITTED TO DEVELOP THAT POWER. From the original French of N. L. S. Carnot, graduate of the Polytechnic School. Edited by R. H. Thurston, M. A., LL D., Dr. Eng'g.; Director of Sibley College, Cornell University; "Officier de l'Instruction Publique de France," etc.

This book contains a translation of a treatise entitled "Reflections of the Motive Power of Heat, and on the Machines fitted to Develop that Power," by N. L Sadi Carnot; and it is the first English translation that has been published. The notice on the work of Sadi Carnot, by the editor, calling attention to its remarkable features, and its extraordinary character as the product of a most remarkable genius, and the biographical sketch of the great author, by his brother, Mons. Henri Carnot, are full of interesting reading. To the main portion of the book, Carnot's Reflections, is appended a paper by Sir William Thomson relating to Carnot's theory of the motive power of heat, with numerical results deduced from Regnault's experiments on steam. The appendix contains extracts from unpublished writings of Carnot, and also foot-notes from the same author.

Undoubtedly this work will be appreciated by scientific men, and all others who are interested in the motive power of heat.

The book is published by John Wiley & Sons, 53 East Tenth street, New York. The price of the book is $2.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(244) J. C. S., Boston, Mass., asks: Is there an engine that runs from New York to Hartford and return, whose fire-box is filled with thirty tons of hard coal on starting, and requires no attention until it returns? *A.*—No; nor anywhere else.

(245) J. L. H., Washington, N. J., writes: Please give me a receipt for cementing rubber to iron, such as may be used for band saws. *A.*—The following is recommended: Soak pulverized gum shellac in ten times its weight of strong ammonia. This will make a slimy mass, which, if left to stand for a few days, will become liquid and ready for use.

(246) R. S. V., Warren, Pa., writes: Please state your opinion which your experience would lead you to draw concerning the relative wearing qualities of malleable iron and cast-steel, for the purpose of making cast links for reversible engines that have to be reversed suddenly under full speed. *A.*—We have found that the cast-steel links wear a great deal better than malleable iron castings.

(247) J. B., ——, asks: If I tie a rope to a crank-pin of a locomotive wheel, the pin being on the bottom center, and pull at the end of the rope, in which direction will the wheel turn? *A*—If you pull hard enough, the wheel will tend to move towards you, provided you stand on the ground. 2. Does a locomotive piston travel through the cylinder, or does the cylinder travel over the piston? *A.*—The piston travels through the cylinder.

(248) C. P. S., —— Mich., writes: I understand that there is more than one way to compute the horse-power of an engine. Which do you consider is the method? *A.*—See answer to Question 25, in our issue of January 16, 1890. 2. What is a compound lathe? *A.*—There is no such thing as a compound lathe. There are compound geared lathes; this term refers to the back gear on the head stock, and to the gears of the feed. There are also lathes with a compound rest.

(249) R. H., Cleveland, O., writes: Please advise me as to the best method of testing case-hardened iron plates, as regards to the uniformity of hardness of surface. The plates are very hard; a small piece can not be worked at all with the hardest twist drill.

The plates will be ¼x8 inches, and 14 feet long. I am very desirous to know that they are of a uniform hardness all over the surface. *A.*—We do not know of any other way than to test the surface with a file. As to the depth of the case-hardening, the plates will have to be cut before the depth can be determined.

(250) F. E. W., Greenfield, Mass., asks: Is it better to use the exhaust steam from an engine in the water heater and then in the pipes for heating purposes, or the reverse? *A.*—We prefer to let the exhaust steam pass into the water heater first, and then use the remainder for heating purposes. 2. Is it good practice to pump the water from the condensed exhaust steam back into the boiler? *A.*—Yes, provided that great care is taken in oiling the cylinders, so that the exhaust steam will carry very little oil with it. The oil used for cylinders should be a mineral oil, and not animal oil; if the latter is used we should not pump the water from the condensed exhaust steam back into the boiler unless the exhaust steam is run through a separator, of which there are several on the market.

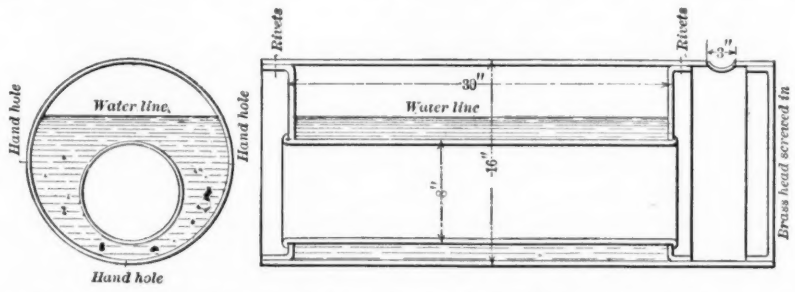
(251) J. L. P., Boston, Mass., writes: Please inform me how to clean brass drawpulls on furniture, so that they will stay bright and not tarnish? *A.*—Brass will tarnish in time, no matter how it is polished. To prevent tarnishing you will have to get them plated. 2. Also inform me in regard to the best way to finish furniture to get a polish after the same is sand-papered. I have an old-fashioned piece of furniture inlaid in different woods. I have sand-papered some all over, and want to put on a finish that will not color the woods. *A.*—The manner of finishing the surfaces before varnishing or polishing will depend on the kind of wood, as all woods should not be treated alike. Our advice to you is to give the work to a person who understands the business. It is considered by some a very difficult matter to polish furniture satisfactorily.

(252) J. S. C., New York, writes: I had occasion to set the valves for a pair of propeller engines. I had no trouble to set them to go ahead or astern, giving them the proper lead, etc., but with the link in the center I found the lead to be fully twice as much as when the link was in full gear. Why is it so? Have I overlooked anything, or is it for the want of knowing how to set the valves? *A.*—You have set the valves right. The increase of lead when the link is in mid gear is due to the eccentric rods crossing each other during one revolution. If you had connected the go-ahead eccentric rod to the other end of the link, bringing the backing eccentric rod to end of the link to which the go-ahead eccentric is now connected, there would have been no lead when the link is in mid gear, and this would not be satisfactory in marine work. This increase of lead cannot be avoided.

(253) J. Mc.M., Chicago, Ill., writes: I am greatly interested in the answer to Question 220; but there is one part of the answer which I do not understand, and which I would like you to make clear. You say the circumference of a circle is equal to 6.2832 times the radius, consequently the amount of work performed is equivalent to $\frac{4,125}{6.2832} =$ 656.5 pounds acting on a wheel of 1-foot radius. Now, what I would like to know is: Why do you divide the foot-pounds 4,125 by 6.2832? *A.*—The number of units of work performed by a force is equal to the product of the force by the distance through which the force acts. Now, 4,125 foot-pounds is the number of units of work performed by a force, and this force has acted through a distance equal to the circumference of a circle whose radius is 1 foot, and since the circumference of this circle is 6.2832 feet, the force must be equal to $\frac{4,125}{6.2832} =$ 656.5 pounds.

(254) A. B., Philadelphia, asks: Please state how to calculate gears to cut a thread on the Harrington extension lathes. *A.*—This is a very good example of how a question should not be asked. We don't know how to calculate gears for the particular lathe mentioned, for the reason that we know nothing of its construction; but A. B. will find rules printed in the answer to Question 123, issue of March 27, from which the conditions applying to the lathe can be selected, and the rule applied. 2. Please state the quickest way to calculate the speed of a lathe that is running, or any other machinery; or in other words to calculate speed? *A.*—The quickest way we know of to calculate speeds is to take the diameter of all the driving pulleys, and multiply them together, commencing with the first one you know the speed of, and this product by the speed of the first one. Divide this product by the product of all the driven pulleys multiplied together. The shortest way of accomplishing this operation is by cancelation, which you will find fully and clearly explained in almost any arithmetic.

(255) E. H. C., Bethlehem, Pa., writes: Please give me the size and description of a boiler which you think is the best and most economical for generating steam of 50 pounds pressure to run a small engine whose cylinder is 1½ inch diameter, and 2-inch stroke; number of revolutions, 500 per minute. Gas for fuel. Give also the thickness of metal required for the boiler. *A.*—The form and dimensions of the boiler which we should adopt are given in the accompanying sketch. The outside shell is a piece of a lap-welded tube; the thickness of that size tube is generally .27 of an inch. The inner shell is another piece of a lap-welded tube about .165 of an inch thick. The heads we should make of about $\frac{3}{16}$-inch iron, riveted to the outer shell as shown, and the inner flue we should expand in the heads. For the smoke-box end you may use a brass cap screwed into the outer tube. The furnace door end will have to be made to suit the burner. We recommend this boiler because we believe it is the cheapest one to make, and will be a safe one. There are other forms of boilers on the market specially made for burning gas, with which a greater economy can be obtained; but most of these boilers are patented, and you cannot make them yourself. 2. What will be the horse-power of the engine? *A.*—About one-eighth of a horse-power.



(256) C. O., ———, asks: Can you tell me of some way to harden a lathe center without springing it; the center is short (that is, turned up close to the square place), and the angle is 90°? I have no way of truing it after it is hardened. *A.*—There is no way of doing this. If you have no way of truing the center after hardening, it must be soft enough so that it can be turned. 2. What is the object of having a plate in the Corliss valve? *A.*—We are not sure that we understand what you mean. There is no plate in the Corliss valve, though the valve-stem is flattened out where it passes through the valve, so that it may be said to resemble a plate, the object being to give motion to the valve, and at the same time allow it to be kept tight on its seat by the steam and small springs, which are usually put in. If you mean the wrist-plate, its object is merely to furnish a convenient means of supporting and giving motion to the various wrist-pins controlling the valves. Arms arranged around a central hub have been used in place of it. For the advantages gained by the use of these wrist-pins so mounted, we must refer you to books which treat of the subject. 3. What is the rule for proportioning boiler stay-bolts and braces? *A.*—You will find this matter explained in the answer to Question 15, issue of Jan. 9. 4. What is the standard taper for keys? *A.*—There is none that we are aware of, but ¼ inch to the foot is used more than any other taper, perhaps.

(257) J. T. B., Anniston, Ala., writes: We have built a double engine, cylinders 5 x 6 inches, to run our foundry, which is about 100 feet from the boiler, and we have set the engine at that distance from the boiler. Now, this boiler is about 20 horse-power; we carry about 60 pounds of steam. The same boiler runs our machine shop engine, which also has two cylinders 6 x 12 inches with only a few tools to pull. The piping leading to the foundry engine is 1½ inches diameter with several elbows between boiler and engine, which I think is a disadvantage. The foundry engine has to run a 35-inch blower and two countershafts. We find this engine will not do the work; it will run, but not fast enough. The steam led through this long distance seems to be all right, as it does not condense very much. The steam from the boiler is to run the two engines. The 6 x 12 engine is within 10 feet of the boiler. Now, what we want to know is, why the foundry engine will not do the work; it has $\frac{1}{16}$ inch lead, is that all right? *A.*—The lead, although somewhat excessive, is not the cause of making the engine run too slow. We believe that the steam pipe is too small; it should not be less than 2 inches diameter; in fact, it may need to be greater to suit the speed of engine, which you have not given. We also notice that if both engines are run at their full power at the same time, the boiler is too small for the work required of it; and the machine shop engine being much closer to boiler than the foundry engine, is liable to draw the steam from the latter. To locate the trouble correctly it will be necessary for you to take some indicator diagrams, which in all probability will disclose the cause of trouble.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

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Over 50,000,000 feet of Link-Belt in use.
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Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See June 5, p. 18. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

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C. H. Redman & Co., Newark, N. J., Manufacturers of Light Machinery, Automatic Selling Machines, Telephone and Telegraph Instruments, Sewing Machine Attachments, Models, etc. Contracts solicited.

For Sale—Bound volumes of the Patent Office Gazette for years 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

Machine Tools for Sale—One 8-ft. pulley lathe, $500; one 18-inch New Haven lathe; one 36-inch drill press. Lot vises, anvils, general outfit of machine shop; cheap; no further use for them. Logan Machine Works, Oil City, Pa.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

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Just concluded. "Practical Drawing." By J. G. A. Meyer. Copies of the American Machinist containing the above series of 93 articles sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

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"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

MANUFACTURES.

A large flour mill is to be erected at Warrenton, Va.

Milledgeville, Ga., will have a large canning factory.

An electric light plant will be put in at Jamestown, R. I.

A $50,000 yarn-mill is to be established at Kershaw, S. C.

A wall paper factory will be established at West Newton, Pa.

The Olympia (Va.) Woolen Mills will be removed to Marion, Va.

A machine shop is being established in Macon, Ga., for general repair work.

G. H. Barker, Waldo, Fla., whose saw-mill was recently burned, is rebuilding.

The Union Mill Company, capital $1,000,000, has been organized at Nashville, Tenn.

The Attalia (Ala.) Iron Company, capital $400,000, will erect an iron furnace and rolling mill.

The alliance are to build a warehouse and probably a cotton-oil mill at Bamberg, S. C.

A capital stock of $100,000 will erect foundry and machine shops at Orange Lake, Fla.

Bangs Bros. and the Cushnoc Fiber Company of Augusta, Me., are to build new factories.

The Cairo Electric Street Car Company, of Cairo, Ill., will build and operate an electric railway.

The Cherokee Falls (Cotton) Manufacturing Company, Blacksburg, S. C., will increase its plant.

The $1,000,000 cotton-mill at Huntersville, Ala., is to be built by citizens and Eastern capitalists.

An electric light company with a capital stock of $10,000 has been incorporated at Rock Hill, S. C.

Electric light plant, water-works and street railway are to be established at Blacksburg, S. C.

The Springfield Boiler and Manufacturing Company has been chartered to build boilers at Springfield, Ill.

The Union Paper Mills at New Hope, N. J., were recently set on fire by lightning and partially destroyed.

The Norfolk & Western Railroad Company will erect machine shops at Lambert's Point, near Norfolk, Va.

The Hamburg (N. Y.) Water and Electric Light Company has increased its capital stock from $12,000 to $50,000.

G. S. Rorke & Co., of North Stonington, Conn., will remove their knitting mill and broom factory to Bainbridge, Ga.

The Greenville Land and Manufacturing Company, Greenville, Miss., is making arrangements to erect a cotton-mill.

DeLancy Evans has erected a saw-mill at Wilmington, N. C., and will probably add shingle machinery and dry-kilns.

The Plaquemine Lumber & Improvement Company, Plaquemine, La., whose shingle mill was lately burned, will rebuild.

The Pennsylvania Salt Manufacturing Company, of Natrona, Pa., have put in an Archer fuel gas plant in place of natural gas.

A stock company will establish a sash, door and blind factory at Abbeville, S. C. It is to be organized by R. E. Hill and others.

The new mill for the Haynes, Booth & Hayden Company of Waterbury, Ct., will be 160x100 feet, and will be built wholly of iron.

A number of improvements are being made to the plant of the Harvest Stove Manufacturing Company at South Pittsburg, Tenn.

Northern parties have submitted a proposition to the Texas Mining and Improvement Company, at Marble Falls, Tex., to erect a cotton mill.

The Emory Planing Mill Company at Harrman, Tenn., will erect a lumber mill and sash, door and blind factory. The capital stock is $25,000.

The Cherokee Iron Manufacturing Company is the name of the New Orleans company that is to build iron works at New Birmingham, Tex.

The Southern Lumber Company will build at East Chattanooga, Tenn., a planing mill 65x150 feet, and a dry kiln and a storage shed 150 feet long.

Judge D. R. Wingate's large saw-mill, at Orange, Texas, was recently destroyed by fire. It is believed that it will be rebuilt by a stock company.

A company has been formed at Hartford, Conn., called the Farmington River Power Company, to utilize the water-power of the Farmington River.

The West Superior (Wis.) Iron and Steel Company proposes to build a Bessemer works and rolling mill for steel plates, beams and structural shapes.

F. H. Holloway, of Burnet, Texas, and others have incorporated the Union Compress Company, to build a compress at Austin, Texas. Capital, $100,000.

The charter of the Dublin Compress and Manufacturing Company, Dublin, Texas, has been filed. T. C. Oldham is among the incorporators. Capital stock, $30,000.

The City Manufacturing Co. of New Bedford, Mass., is building an addition 25x50 feet, one story high, on the south of its mill, to be used as a machine shop.

The Somersworth Machine Company at Great Falls, N. H., has secured the contract for furnishing the shafting and iron work for the new machine shop at Exeter, N. H.

The Electric Manufacturing Company of Troy, N. Y., is to increase its stock to $75,000, and go into the manufacture of gas engines and electric and other machinery.

De Leon Springs Company, of De Leon Springs, Florida, will increase their capital from $160,000 to $300,000. They will establish water-works in connection with their hotel.

W. H. Forbes, J. S. May, Philip Engelskirger and others, have incorporated the National Saw Company at Newport, Ky., to manufacture saws. The capital stock is $3,000,000.

Macon will have a mammoth tin-ware manufactory. The capital stock may be $250,000. The members of the Macon (Ga.) Hardware Company are the main movers in the scheme.

The Peace River Phosphate Company, Florida, has purchased new driving machinery and can handle twenty tons of rock per hour. The company expects to add other machinery.

The Union Mill water power, at Potsdam, N. Y., has been sold to James A. Outterson, who will organize a company to establish at that point a wood pulp mill, a sulphite fiber plant and paper mill.

The Keystone Bridge Company, Pittsburgh, Pa., has just completed a girder for the new city hall at San Francisco, which is said to be the largest ever made in this country. It is 105 feet long and weighs 70 tons.

W. A. Wilson, J. L. Page, S. Montgomery and others have incorporated the Southwest Georgia Alliance Manufacturing Company at Americus, Ala., to establish a cotton factory. The capital stock is $30,000.

The Norwich (Conn.) Folded Paper Carpet Lining Company have leased a shop in Thamesville, Norwich, and will move their machinery there from Bozrahville at once. Work will begin in the new mill about July 1.

The Howard-Harrison Iron Co., of St. Louis, has been formed from the well-known Shickle, Harrison & Howard Iron Co., of that city, to found an extensive plant at Bessemer, Ala. The parent company employs 1,000 men.

The new dry plate factory of Stanley Brothers at Newton, Mass., is being fitted up with machinery from the plant at Lewiston, Me., where the business has been carried on. The Newton factory will be running in a few days.

A company has just been organized at Monroe, N. C., with a capital stock of $100,000, to build a cotton factory there. Mr. A. Stevens is president, and Messrs. Houston, Vann, Fairly and Adams are directors. Work will begin at ouce.

The American Wheel Company, of Chicago, has purchased White's Wheel Works, of Fort Wayne, Ind. It is one of the largest wheel factories in the State. The same trust also controls N. G. Olds & Sons' Works, of Fort Wayne, and now operates 14 plants.

It is reported that the Milwaukee Bridge and Iron Company contemplates the erection of a new plant at Milwaukee, Wis. The main building will be 600x100, and the works, exclusive of machinery, will cost $175,000. The working force will be doubled.

Arrangements have been made for the occupancy of the 1,000,000-dollar cotton mill that is to be erected at Highland Park, near Montgomery, Ala. The machinery of a large cotton mill in Philadelphia, Pa., is to be removed, and placed in the new mill as soon as completed.

The Dominion Railway Supply Company (limited) is the name of a Canadian company applying for a charter of incorporation for the manufacture and sale of general railway appliances, etc. The amount of capital is to be $100,000, and the head office of business is Windsor, Ont.

Cedartown, Ga., is trying to raise one-half of $35,000 to establish a knitting mill at that place. Mr. A. H. Elwood, president and general manager of the knitting mills at Tallapoosa, Ga., says that an investment to that amount will equip and give working capital to a mill that will give employment to over 200 operatives, and pay 27 per cent. dividends.

R. W. Hill, at Waterbury, Conn., is preparing the plans for Blake & Johnson's new factory on North Elm street. It is to be of heavy brick construction, three stories and basement, about 200x48 feet. There will be additions for boiler and engine-rooms and the factory will be equipped with elevators and all facilities for manufacturing in the company's special lines.

The Indian Orchard Mills Company at Springfield, Mass., have a large force of men at work on their property. They are putting in the foundation for a dye-house 140x40 feet, and expect their new machinery in a few days. They have taken down the old cloth-room which stood near the Athol depot, thereby making a decided improvement in the appearance of the No 1 mill.

Amendatory articles of incorporation were filed recently, by which the authorized capital of the McCosh Iron and Steel Company, of Burlington, Ia., is increased from the present limit of $200,000 to $500,000. This large addition to its stock is rendered necessary by the extensive additions now being made by the company. The company now employs close to 300 hands. The additions being made will nearly double this force.

The negotiations which the Middlesborough (Ky.) Town Company have been conducting with the South Boston Iron Works, looking to the removal of the latter to Middlesborough, have come to a successful close. It is reported that the contract for the removal of the works has been signed and delivered. Middlesborough is thus assured of an addition to her industries of one of the largest ordnance manufacturing concerns in the country.

The Fishkill Landing Machine Company, Fishkill-on-the-Hudson, N. Y., has just issued a very neat and attractive catalogue of the Fishkill-Corliss engines made at the works, containing full illustrations and descriptions. The recent changes that have been made in these engines are shown by detail cuts of parts. The catalogue also contains a cut and list of sizes of slide valve engines. Business, we are informed, is very good indeed at these works.

E. T. Burrowes, screen manufacturer, Portland, Me., is to further enlarge his extensive screen factories in that city. For this purpose a new building will be erected to adjoin the factory on Spring street, and front on Free street. The new building will be 70x150 feet on the ground, and be four stories in height above the basement. The front will be of fire-proof brick handsomely trimmed with hammered stone. The new building will give facilities to more than double the present capacity of the manufactory.

Underground Explosions.

What a muddle the various companies that run pipes and wires under the streets of New York manage to keep things in. First the pipes of the gas companies, by long continued leaking, have saturated the ground with gas until it is extremely noxious, and, we believe, unhealthy, when dug up. The reason these leaks—which are everywhere that the pipes are—are not stopped, is that it is cheaper to permit the gas to go to waste. Ater the gas companies come the steam company, and this is the company in whose interest the greater part of the digging up of streets has been done. Steam is expensive, and steam leaks are costly to maintain under a pressure of eighty pounds. When this digging and repairing is going on there appears always to be danger of an explosion. All the elements of a first-class volcano, as is frequently demonstrated, are down amongst the network of pipes under the streets. The latest breaking forth—at this writing—was at the crossing of Broadway and Fulton street. It was a first-class exhibition in the way of a blaze, defying the efforts of the firemen to subdue it. As a good deal of damage has been done to gas pipes and electric light wires, it appears probable that lawsuits will grow out of the matter, but this will not settle anything. That will not be accomplished until the pipes go into a tunnel, as we have before pointed out. With things as they are it is some satisfaction to know that there is not room for many more pipes to add to the danger that lurks beneath the pavement.

[Since the foregoing was written there have been several more explosions, but they "don't count."]

Force, Motion and Work.

BY PEDRO.

TWELFTH PAPER.

STATIC AND DYNAMIC FORCE.

In the last paper we have seen that force is an effect; not that force is the effect itself, but the latter is a measure of the former. We speak of the effect as though it was the force, because we do not know any better. We do not know what force is, hence we may, for convenience, call its effect the force. This is done every day in connection with various phenomena. We do not know what light is—there is an abundance of theories — therefore we call the effect light. We do not know what heat is, hence we call its effect heat, etc. When we say that the stove is hot, we, of course, do not mean that the stove is the heat. We say that the fire is hot, but we do not mean that the fire is the heat, nor that the fuel is the heat, but what we really do mean is that the fuel contains the elements of heat (or *some* of the elements), and when it is placed under certain conditions which have been determined by experiment—as in the stove—the heat contained in the fuel becomes sensible; that is, a phenomenon is produced which we can always detect by means of the effect it produces on our senses, either directly or indirectly.

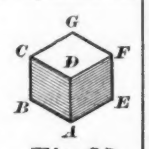

Fig. 28.

In the same manner force makes itself known by the phenomenon of motion; it becomes sensible only through the motion of matter, viz., the effect produced. This effect, we have seen in the last paper, we measure by the product of the amount of matter or weight in the body moved, and the space passed over. It is perfectly proper, therefore, when convenient, to call the effect the force.

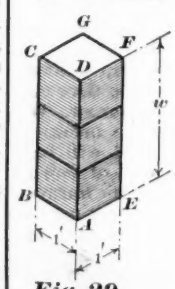

Fig. 29.

In the eleventh paper, Equation 35, we have seen that an effect is represented by the continued product of the amount of matter in the moving body, the average velocity or the space passed over in the unit of time and the time of the motion. Hence the systematic unit effect is obtained by the unit of matter, the unit of space and the unit of time. The unit of matter is called a *pound*, and is represented by the standard piece of platinum referred to in the tenth paper. The unit of space is the foot, and for the unit of time we have adopted the minute. Here we see that the effect produced is measured by three dimensions—the foot, the pound and the minute. Hence, if we should name an effect or force by its dimensions, we would say that an effect was produced of so many *foot-pound-minutes*—three dimensions.

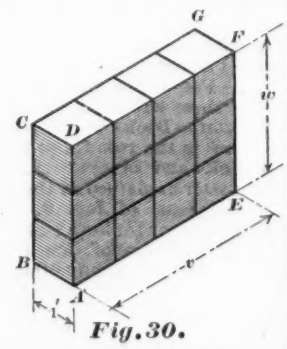

Fig. 30.

The systematic unit of force may be represented by a geometrical solid, Fig. 28, in which the space, the weight and the time are each drawn to the same scale of feet; that is, $A\,E$ = one foot, represents the space passed over in one minute, or the average velocity. The time, one minute, is represented by $A\,B$ = one foot. The height $E\,F$ = one foot, represents the weight—one pound. Fig. 28, then, represents the unit force of *one foot-pound-minute*. This force is represented in Equation 38, eleventh paper, when the weight w is one pound.

When the weight of the moving body is more than one pound, then Equation 38 is represented by Fig. 29, the number of units of force being the same as the number of units of matter or pounds in the moving body. This is called the *static force*, because the force is equal to the weight of the body, which (weight) is always the same whether there is motion or not. "Static" meaning standing still or at rest, we may know what the static force of a body is without setting it in motion. In other words, the resistance necessary to prevent the force from moving the body is the same as the static force acting on the body, according to the third law of motion.

If the average velocity is greater than one foot a minute—Equation 36, eleventh paper—then the force is geometrically represented by Fig. 30. The product of the weight $F\,E$ by the average velocity $A\,E$ and the unit of time $A\,B$ is the cubic contents of the volume or the number of blocks in the pile, each of which represents a unit of the force. Therefore the number of blocks or volume is the number of foot-pound-minutes in the force. This is called the *accelerating force*, because it is the amount of force required to generate

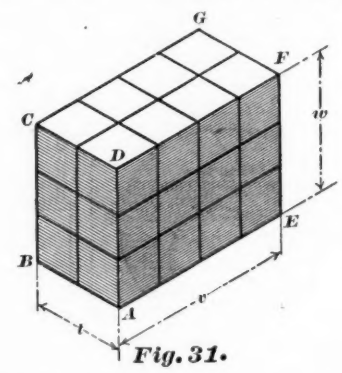

Fig. 31.

in a body a velocity, in the unit of time, which is equal to the acceleration, as shown by Equations 37 and 43, eleventh paper.

Fig. 30 represents an effect or force generated in the unit of time. Now let us take the effect produced in a time t. This will be represented by Fig. 31, as shown by Equation 35, eleventh paper, the number of blocks or units of force being the product of $F\,E = w$, $A\,E = v$ and $A\,B = t$. This we call, generally, *dynamic force*, because it depends upon the *quantity of motion* (space) generated in a time t, as well as upon the weight of the body.

Here we observe that force in general is a function, and not an element, but that it is measured by the three elements, matter or weight, velocity and time, and that the force or its measure is the product of the three elements. Static force, Fig. 29, is the *space rate* at which accelerating force, Fig. 30, is generated, since this is the dynamic force generated in the unit of time; that is, when a body moves with a variable velocity, the static force is the *velocity rate* at which dynamic force is generated. The dynamic force, Fig. 31, we see, is generated at a *time rate* represented by the accelerating force, Fig. 30. Or it may be regarded as generated at a double rate, viz., a *velocity rate* and a *time rate*, and this double rate is the static force, Fig. 29.

The diagrams representing the above three classifications of force, when the body moves with a uniformly accelerated motion, are as follows: Fig. 32 represents the static force, being measured by the dynamic force generated in the unit of time over a space of one foot. This requires an acceleration of two feet, since the space passed over in this time is one-half of the acceleration.

The accelerating force is shown in Fig. 33, which corresponds with Fig. 30. Compare this with Equation 37, eleventh paper.

The dynamic force, generally, is represented in Fig. 34 and Equation 35, eleventh paper, or if we represent the absolute dynamic force by F_0, then we have from Equation 35, since $v = \frac{a}{2}$,

$$44 \ldots\ldots\ldots F_0 = \frac{w\,a\,t}{2}.$$

Or, since $a\,t = V$ (fourth paper),

$$45 \ldots\ldots\ldots F_0 = \frac{w\,V}{2}$$

This equation is represented in Fig. 34.

As we have stated before, the foregoing measures of force are based upon the *systematic unit*, which is called the *absolute unit*

of force. (Some writers call w V the absolute force.) This, however, is not the unit of force in common use. Force, unlike other unsystematic units, being already unsystematic in the measure of its primary element, mass, is made still more unsystematic by adopting a *gravity unit* of linear measure, instead of the foot, for measuring the space passed over by a body, due to the force of gravity. That is, the space passed over in the unit of time by a falling body—by the motion caused by the force of gravity—is one-half of the acceleration $\left(\frac{1}{2}g\right)$ of gravity.

This motion taken as the unit of space, multiplied by the unit of matter, the pound, is regarded as the *gravity unit* of force which

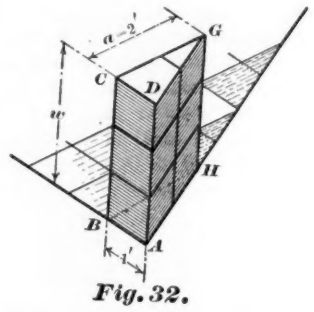

Fig. 32.

is the unit in common use. To reduce absolute force to gravity or common force, we must, therefore, divide the space of the former by $\frac{1}{2}g$, if measured in feet or other units than $\frac{1}{2}g$, to reduce the space from such units to *gravity units.* By so reducing the formulas, we get from Equation 37, eleventh paper,

$$46. \ldots\ldots f = w\frac{a}{g}.$$

This is the same result as obtained in Equation 43, but instead of the unit force being a "foot-pound-minute," it is now a *gravity-pound-minute,* as shown in Fig. 35 or Fig. 36.

Rule 46.—The accelerating force of a body is obtained by *multiplying its weight by the number of gravity units of space described in the unit of time, or, which is the same thing, by multiplying the weight of the body by its acceleration and dividing by the acceleration of gravity.*

These are the facts as they actually exist, though they are not generally so stated in books on mechanics. Absolute force is usually reduced to gravity force by dividing the weight of the body by the acceleration of gravity $\left(\frac{w}{g}\right)$, and calling this "the mass."

Of course this gives the same result in the end, as shown by Equation 46, but it is illogical, inconsistent, and certainly does not help to enlighten an already otherwise confused subject. "The standard pound is a

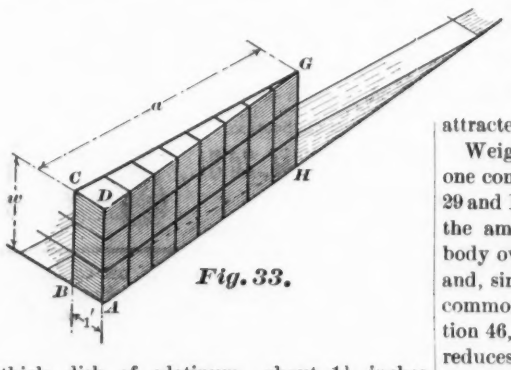

Fig. 33.

thick disk of platinum, about $1\frac{1}{6}$ inches across and one inch high, with a shallow groove around it near the top." This piece of platinum, called "the standard pound," is the unit of mass which *has been legally adopted* (in England, at least, and in the United States by custom), hence there is no good reason for taking something else for the unit of mass.

Again, taking $\frac{w}{g}$ as a new measure of mass makes it a variable quantity, since g is not the same in different localities. The quantity of matter in a given body is absolutely constant, and cannot be changed by simply carrying it from one place to another.

And still again, such a measure of mass not only varies with the locality, but it varies still more with the unit of time that may be adopted. For example, if the second is the unit of time used, then a body weighing ten pounds would contain $\frac{10}{32.16}$ of a "unit of mass." No "feller" can tell what this unit is; it is not a pound; it is not a cubic foot; in fact, it represents no unit in existence. It ought to have been called a co-efficient of ignorance. If the minute is adopted as the unit of time, then $\frac{w}{g} = \frac{10}{115,776}$ of a "unit of mass." This is only $\frac{1}{8800}$ part of the former case, still the actual quantity of matter has not been changed, therefore such a "unit" is an absurdity. The quantity of matter in a body is always the same, whatever its position or whatever the unit of time may be.

Of course the measure of a *force* is subject to the same variations as long as the local effect produced by gravity is taken as the standard of comparison, but when a young man studying mechanics is told to divide 50 pounds of beef by five feet, or 32.16 feet $\left(\frac{w}{g}\right)$, he does not know what it means. He can divide the abstract number 50 by 5, and obtain 10 as the ratio, but what this means he does not know, and can find nobody who can tell him. But if he is told to divide 50 feet by 5 feet $\left(\frac{a}{g}\right)$, he knows at once that $\frac{1}{5}$ of 50 feet is *ten feet*, or that the motion by which force is measured is g times a certain number of *feet*. Also this measure of space $\left(\frac{a}{g}\right)$ is always the same, whatever be the unit of time adopted.

The Encyclopædia Britannica says on this point: "According to the system followed till lately in treatises on dynamics, the unit

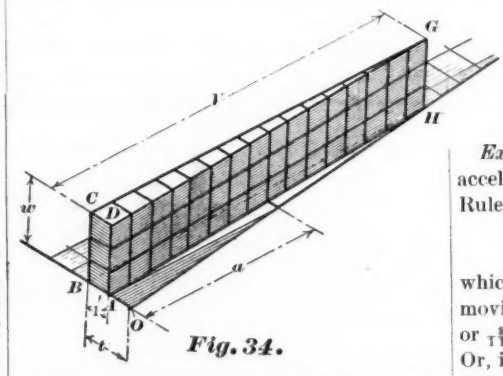

Fig. 34.

of mass is g times the mass of the standard weight, g being the numerical value of the acceleration produced (in some particular locality) by the earth's attraction. This definition, giving a varying unit of mass, is exceedingly inconvenient. In reality standards of weight are *masses*, not *forces.* They are employed primarily for the purpose of measuring out a definite *quantity* of matter, not an amount of matter which shall be attracted by the earth with a given force."

Weight is a measure of force only under one condition, and that is represented in Fig. 29 and Equation 38, viz.: *Static force*, which is the amount of force necessary to move a body over a unit space in the unit of time; and, since $\frac{1}{2}g$ is the unit space used in the common system of measuring force, Equation 46, when $\frac{1}{2}a = \frac{1}{2}g$ (the unit), or $a = g$, reduces to

$$47. \ldots\ldots f = w.$$

Rule 47.—That is, *the static force is always equal to the weight or quantity of matter in the moving body.*

This is the only sense in which weight can be called a force, as we have also seen in Equations 38 and 40.

Reducing Equation 45 to common or gravity force, we get

$$48 \begin{cases} \text{I.} \ldots\ldots F = \dfrac{w\ V}{g}, \\ \text{or from Equations 44 and 46:} \\ \text{II.} \ldots\ldots F = f\ t. \\ \text{III.} \ldots\ldots F = \dfrac{w\ a\ t}{g}. \end{cases}$$

Rule 48.—The dynamic force measured in common units is obtained:

I.—*By multiplying the weight of the moving body by its velocity, and dividing by the acceleration of gravity;* or

II.—*By multiplying the accelerating force by the time of motion;* or

III.—*By taking the continued product of the weight of the body, its acceleration and the time of motion, then dividing by the acceleration of gravity.*

Since forces are measured by the effects they produce, they may all be ultimately reduced to the form of a static force; that is, Fig. 30 representing an accelerating force of 12 foot-pound-minutes, or 12 gravity-pound-minutes, according as v is measured in absolute gravity units, may be put in the form of Fig. 29, the time and space being unity, and

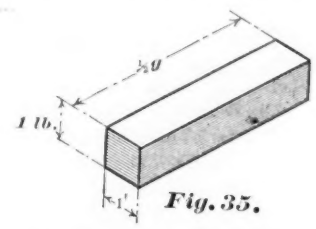

Fig. 35.

the weight 12 pounds instead of 3. In the same manner we may regard the dynamic force, Fig. 31, being equivalent to a static force of 24 pounds. With this understanding that the elements time and space are always reduced to unity in measuring force, they need not be mentioned in naming the force, but it may simply be called a force of so many *pounds*, since in a static force the number of pounds of matter in the body is equal to the number of units of force.

From Equation 46 we get

$$49. \ldots\ldots\ldots\ldots a = \frac{f\ g}{w}.$$

Rule 49.—To find the acceleration of a body *multiply the accelerating force by the acceleration of gravity, and divide by the weight of the body.*

Example 1.—The weight of a body is 270,000 pounds, hence its static force by Equation 47, is 270,000 pounds, which is the force required to move the body over a space of one gravity unit, $\frac{1}{2}g$, in the unit of time.

Example 2.—If the body is moved with an acceleration of 2,500 feet a minute, then, by Rule 46, the accelerating force

$$f = \frac{270,000 \times 2,500}{115,776} = 5,830. \text{ pounds,}$$

which is the dynamic force generated in moving the body over a space of 1,250 feet, or $\frac{2500}{115776}$ of a gravity unit in one minute. Or, it is the *static force* required to move the body over a space of $\frac{2500}{115776}$ of a gravity unit—.0216.

Example 3.—The dynamic force generated in ten minutes is, by Rule 48 (II),

$$F = 5,830 \times 10 = 58,300. \text{ pounds.}$$

That is, the force which generates in the body a velocity of $2,500 \times 10 = 25,000$ feet,

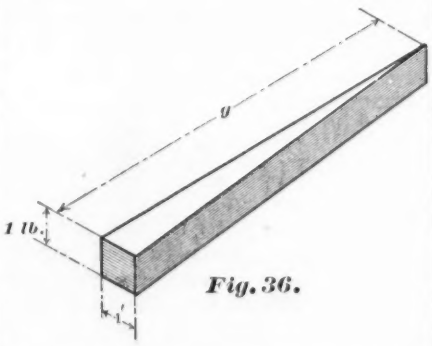

Fig. 36.

produces the same effect in ten minutes as a static force of 58,300 pounds will produce in one minute.

Example 4.—If the accelerating force of a body is 3 pounds, and the weight of the body is 12 pounds, what is its acceleration? By Rule 49

$$a = \frac{3 \times 115,776}{12} = 28,944. \text{ feet a minute.}$$

A correspondent of a German paper says that of all institutions in Italy railroads have been least developed, falling behind the standard set in any of the European countries, not only as regards comfort and speed, but also safety and systematic management. The fitting up of the passenger cars is very poor, which is true even of the first-class cars. As a consequence of the scarcity of cars, the trains are overcrowded, and the return of rolling stock of other railroad companies is frequently delayed for long periods. There are frequent accidents, many of which are due to the extensive use of single tracks. Even those roads having the heaviest traffic have double tracks only for short distances. The *personnel* is said to be small in number and poor in quality, being very poorly paid.

Shop Notes.

AN AMERICAN MACHINIST man visiting the works of the Morgan Engineering Co. recently, for the purpose of seeing in operation the largest traveling crane in the world, saw at the same time many other things of interest to any one capable of appreciating a well-arranged and well-equipped plant.

One of the first things noticed on approaching the works is the air of neatness and order which seems to pervade them; nothing seems to be without a place, and nothing out of its place, but the shops and all their surroundings are clean and in perfect order.

The first portion of the buildings which a visitor naturally sees the inside of is that devoted to office purposes, which is new, and to which a good deal of study has evidently been devoted, to the end of rendering them as convenient and comfortable as possible. The office rooms are elegantly fitted up and furnished, and it is especially noticeable that they are so arranged that each man with his assistants in charge of a department of the office work has a room devoted to his especial use, so that he neither interferes with the work of others, nor is interfered with in the least by others. This is carried out even in the case of the stenographer and type-writers, who have a room devoted to their use fitted with every appliance needed for their work, and where the monotonous click of type-writers annoys no one else. Two drafting-rooms are provided, the main one, which is in charge of Mr. John R. Morgan, the chief engineer, being on the top floor, where light is secured from above, and fitted with every modern convenience in the way of tables, cabinets, etc. Twenty-seven draftsmen in all are employed, and there is now being fitted up a second drafting-room, in which all drawings of an experimental nature, or for the patent office, will be made. A very complete patent library is kept in this room. Another room is devoted to the drawing connected with the electrical work, while yet another one is devoted especially to consultations with those who may come to the works investigating with a view to ordering. This room is fitted with large tables, specially arranged for spreading out drawings for inspection, blue prints of all productions being kept at hand for convenient reference.

The shops, in which about 600 men are at present employed, are equipped mostly with new tools, some of them exceptionally heavy, as might be expected from the character of the work done here. Every floor on which there is any heavy work to be handled is provided with traveling cranes, one of these being driven by electricity. This electrically-driven crane has been in use about fifteen months, and, so far as known, is the first crane to be so driven. No changes from the first designs have been made in it, and its working is seen to be very satisfactory, the speed being more readily controlled and varied than by any other system. The current is conveyed to it by two iron bars, which pass along the wall beneath the track upon which the bridge travels.

All departments of the works are connected by telephone, there being a regular outfit for this purpose with central station and all, so that any head of a department can place himself in communication with any other department at short notice, and without leaving his place. All the lighting is done by electricity, and at present one department of the works is driven by it, so that altogether much more use is made of the current than is usually the case in shops, and a number of dynamos driven by high-speed engines

are employed. In connection with this there is a plan in use for the protection of the men who may be employed on the lines, which is ingenious, and would seem to be worthy of imitation. Certain men are designated, whose exclusive business it is to work on the lines, and each of these men is provided with a brass check, for which a hook is provided in the dynamo room, the hooks for all the checks being ranged along on a board provided for the purpose. Before attempting to do anything whatever on the line, it is the business of the man who is to do it to go to the dynamo room, put his check in his pocket, and take it with him, keeping it until his work is completed. The man in charge of the dynamo room has positive orders not to start the dynamo unless all the checks are in place on their hooks, the absence of a check showing that some one is at work on the line, and the number of the check showing who it is.

Though many kinds of heavy machinery are built in the shops, the building of cranes of various types seems at present to be the heaviest part of their business. Among the cranes recently built, besides the large one for the Navy Department, being two for the Pennsylvania shops at Altoona, which are to be driven by electricity, and are of 35 tons capacity each, two 25-ton cranes for Watervliet arsenal, three of different capacities for the Dixon Manufacturing Co., four for the Niles Tool Works, and one for Russell & Co., of Massillon.

Among the other heavy jobs on hand at the time of our visit was a 35-ton steam hammer, the total weight of which will be 860 tons. A traveling crane is being built to be used in connection with the hammer, which is to have an arm projecting out from the trolley, at one side, from which the work can be suspended, and, as the crane is to be used in drawing out heavy masses of metal from the heating furnace, a rack and pinion movement is to be provided for traversing the bridge. This crane will weigh complete about 120 tons. For Riter & Conley, of Pittsburgh, is being built a large hydraulic flanging machine capable of exerting a total pressure of 400 tons.

Altogether eighty-five men are employed on pattern work at present, not all of these being in the shops of the company, however, as two outside shops are employed. For storing patterns the plan of providing a number of relatively small storehouses has been adopted instead of having them all in a single large building, the idea being to prevent the possiblity of losing them all by a fire. Adjoining the foundry is a room in which all patterns from which castings are wanted are taken and placed under the care of the foundry foreman, who is thus able to keep track of the work coming on, and arrange it to the best advantage regarding the selection of men for certain jobs, and of iron adapted to certain purposes; in short, by having before him all patterns on hand from which castings will be wanted, he is able to look ahead as far as circumstances will permit, and arrange to the best advantage. The foundry is the one part of the works which the march of improvement has not yet reached, the increasing use of steel castings and of forgings relieving it considerably, and causing it to wait while other departments were enlarged and improved. A new foundry is to be put up this season, however, which is to be much larger, and equipped with all conveniences, including traveling cranes driven by electricity.

Among the smaller buildings grouped about the yard in the rear of the main shops is one which is devoted to the purposes of an electrical and chemical laboratory. It is equipped with all that is needed for making such tests and experiments as are needed in the work of the company. It has been found, however, that it is better on some accounts not to have the chemical and electrical laboratories together, and new quarters will be provided for the latter in one of the new buildings to be erected this season.

The foreman of the yard gang (which, of course, is composed principally of laborers) has a small building devoted to his use, in which is his desk and provision for storing all the appliances used by him—all ropes, slings, chains, crowbars, lanterns, and, in fact, everything usually wanted by a gang of laborers about such a plant being here kept, where they can be instantly found when wanted, and everything has its place, in which it is found when not in use, and in good order; it being made a point to see that everything put in here after use is in perfect order for use again; if not, it is made so, or replaced by a new article. This is a feature which is in decided contrast to the plan, or rather lack of plan, pursued in too many shops, and, as may be surmised, it is found to pay.

Another small building of brick, standing near the engine-house, is devoted to the plant for heating the shops. It consists of two of the largest "Sturtevant" blowers, each driven by a separate vertical engine, and placed a sufficient distance apart to admit of the heating coils of steam pipes being placed between them. Air is taken through openings in the top of the building where the purest air is found, heated by the steam pipes, and forced throughout the buildings through pipes by means of the fans. Pains are taken to make the shops comfortable and pleasant to work in, and this system of heating is declared by Mr. Morgan to be highly satisfactory in every respect.

It is evident that Mr. Morgan and his three sons, who are in charge of different departments of the work take great pride in them, and with good reason; it is an excellent plant, and, when the further improvements already fully planned have been carried out, it will be a model of its kind.

The *Journal of the Telegraph* gives the following directions for making a simple storage battery:

Get two half-round porous cups, and a round glass jar large enough for the two porous cups to stand in upright. Get two plates of sheet lead $\frac{1}{16}$ in. thick, wide enough to fit the half-round side of the porous cups, and deep enough to come an inch or so above the top edge of the cups and jar. Solder a stout copper wire or a binding screw to each lead plate at the top. Place the lead plates in the cups, and fill the cups nearly full with a paste made of red lead mixed with a solution of sulphate of soda, thin enough to run like a cement. The glass jar containing the two cups should be filled to within a half inch of top of the cups with sulphuric acid and water, about one part of acid to eight of water. The plates should be marked, so that, in charging, the currents may be sent in the right direction. The cell may be charged by attaching it to a series of a dozen sulphate of copper cells for twenty-four hours, or from a dynamo. A wooden cover may be fitted to the glass jar, and evaporation of the fluid should be replenished by adding water. Two or more cells of this battery will work small motors, lamps, and induction coils; and, if thoroughly charged, will retain a large volume of electricity for a considerable time. After once being well charged, four to six cells of sulphate of copper battery will re-charge it.

The ice question is—to make a bull of it—one of the burning questions of the day. The citizens of New York—and of a good many other cities—believe they are being swindled by the ice companies. Whether they are or are not, they are paying an enormous price for their ice. The only satisfaction there is in the matter is, that this high price will help wonderfully to hasten the time when we shall have artificial ice.

The United States imports 1,000,000 barrels of Portland cement yearly.

Machinists' Supplies and Iron.

NEW YORK, June 21, 1890.

Iron—American Pig.—There has been some improvement noticeable in the general tone of the

BRADLEY HAMMERS AND FORGES.

The BEST HAMMERS in the WORLD RUN BY BELT.

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NO PATTERN ROOM COMPLETE WITHOUT THEM.

Send for circular. Mention this paper.

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FOR LAGGING LOCOMOTIVE BOILERS.

Samples and Descriptive Price List Free by Mail.

We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.

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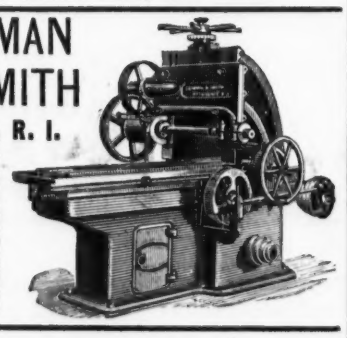

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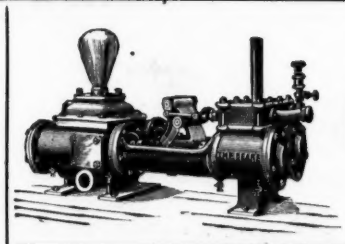

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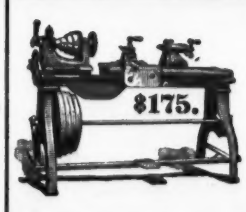

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CAN BE FORGED HOT.

Rods for pumps and bolts. Yacht shafting. Rolled sheets and plates for pump linings and condenser tube sheets, &c. Ingot metal for car and engine bearings. Spring wire.

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WILMINGTON, DEL., MAKERS OF

Metal Working Machine Tools

FOR

Machinists, Engineers, Locomotive Builders, Bridge Builders, Railroad and Car Shops, and Iron and Steel Works Generally.

market during the week, the consumptive demand having increased somewhat, though not sufficiently to affect quotations. The new business has gone mostly to Northern furnaces, Southern producers being pretty well occupied with filling orders previously contracted.

We quote Northern brands No. 1 Foundry, $18 to $18.50; No. 2, $17 to $17.50. Southern No. 1, $17 to $17.25. Southern No. 1, Soft, $16.50 to $16.75; No. 2, $16 to $16.50.

Scotch Pig—Prices are about the same, though somewhat irregular.

We quote Eglinton, $19 25 to $19.50; Dalmellington, $21.50; Summerlee, $23 to $23.50; Coltness, $24 to $24.50.

Bar—Trade has been fairly active during the week, and prices remain about the same.

We quote Common, $1.85; Medium, $1.90; Refined, $1.95 to $2 for round lots on dock.

Copper—There are indications that the extraordinarily heavy consumption has overtaken production, and prices have advanced, with indications of still further advances. It is probable that the "syndicate" stock of copper has been disposed of, and that the market will henceforth be controlled by the producers.

We quote Lake Superior, 16½c.; Arizona Ingot, 15c.; common casting brands, 14½c. Higher prices are foreshadowed by the fact that Lake is held at 17c for future delivery.

Lead—The market has been quiet, but firm, with quotations slightly higher.

We quote 4.45c. to 4.50c.

Spelter—Offerings of Western have been more free, and prices have slightly declined.

We quote Prime, 5½c. to 5⅝c.

Tin—Prices have declined somewhat. In small lots dealers' prices are 21⅞ to 22c.

Antimony—Prices are firm, the spot supply not being heavy.

We quote Hallett's, 21c.; Cookson's, 24c.

Lard Oil—Trade has been dull, and prices have declined to 49 to 50 cents for prime, the latter figure being for ice made.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Exp'd machinist desires sit. M. E., AM. MACH.

Wanted—A lot of good machinists. Address Frick Company, Waynesboro, Franklin Co., Pa.

Exp'd mech. draftsman with tech. education and shop practice, wishes sit. Box 38, AM. MACHINIST.

Wanted—Position by pattern maker (young man), experienced engine and machine work. A1 ref. Address I. X. L., AMERICAN MACHINIST.

Wanted—Good machinists and moulders at good wages with steady employment. Address Ottumwa Iron Works, Ottumwa, Iowa.

Wanted by a practical mechanic a position as foreman of engine works or boiler shop, or as sup't of both. Box 39, AMERICAN MACHINIST.

Wanted—A first-class foreman to take charge of about 40 men building iron working machinery. Address Box 28, AMERICAN MACHINIST.

Wanted—Six first-class machinists and two pattern makers; steady work. Rents and living cheap Address Haxtun Steam Heater Co., Kewanee, Ill.

Wanted—A few first-class machinists. State experience, age, habits, etc., and give reference. The Canton Steam Pump Co., Canton, O.

Wanted—Some moulders and machinists on engine work, about 40 miles from New York City. Address Box 35, AMERICAN MACHINIST.

Pattern makers wanted; one for wood, one for metal. State exp., work familiar with, pay wanted. Illinois Malleable Iron Co., Chicago, Ill.

Draftsman, machinist with technical education and some drafting-room experience wishes a situation Address D. X., AMERICAN MACHINIST.

Wanted—Scrapers and filers, two or three first-class men; steady work and good pay to competent men. Fitchburg Machine Works, Fitchburg, Mass.

Wanted—First-class millwright and pattern maker; man used to elevator work preferred. Call or address 14 Morris street, Jersey City, N. J.

Wanted—Tool maker to take charge of tool room, and capable of making and tempering taps, dies, punches, etc. Address Valk & Murdoch, Iron Works, Charleston, S. C.

Wanted—A first-class foundryman to take contract green & dry sand castings by the ton. Excellent opportunity for 1st class man with some executive ability. Box 36, care of AMERICAN MACHINIST.

A draftsman and designer of machinery desires to correspond with parties having ideas to develop or special work to be put into shape for practical construction. Box 33, AMERICAN MACHINIST.

Wanted—Machinist who has had experience building automatic high-speed engines, to take charge of department. State experience and salary. A. Robb & Sons, Amherst, N. S., Canada.

Wanted—Tool maker; first-class man only, to whom steady work and good wages will be offered. State qualifications and reference in confidence. Address "Cleveland," care AM. MACHINIST.

Machinists Wanted—First-class floor hands and fitters of large experience and of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, O.

Draftsman Wanted—Presses, dies and general machinery. Write, stating age, where last employed, and salary expected, to the Dover Machine Works, Dover, Delaware.

Wanted—Foreman for small brass foundry within 150 miles of Chicago. One used to getting out first-class snap flask and moulding machine work. State age, experience and salary expected. Apply to C. S. H., AMERICAN MACHINIST.

Machinists Wanted—Fifty first-class bench and machine hands wanted. Only those acquainted with high-class machinery need apply. Steady work and liberal wages. Address, Dominion Typograph Co. (Limited), Windsor, Ontario.

Wanted—Several first-class machinists and toolmakers; good wages; pleasantly located shops; best of tools, and splendid openings for advancement of the right men, at Cleveland, O. Address Box 32, care of AMERICAN MACHINIST.

Wanted—A first-class tool maker, competent to make and maintain shop tools, jigs, reamers, etc. Steady work and good pay to a capable and energetic man. Address, with references, The Westinghouse Machine Company, Pittsburgh, Pa.

Wanted—A foundry foreman; a man of steady habits, having experience in handling men, the making of heavy castings in dry and green sand. Apply, stating reference and experience, Lewis Foundry and Machine Co., Limited, Pittsburgh, Pa.

Wanted—A first-class machinist, with capital, to take stock in the Fosmir Iron Works. One with experience to take charge of blacksmith and machine shop. A middle-aged man with plenty of experience preferred. A good opening. Address, for further information, J. F. Fosmir, Station C, Box 144, Los Angeles, Cal.

A thorough practical machinist, age 37, having six years' experience as master mechanic, desires a similar position or a foremanship; familiar with stationary, mill and jobbing work; railroad shop preferred; will go to any part of U. S. or Mexico. Address F. H. B., AMERICAN MACHINIST.

Wanted—Mechanical engineer for a large machine works. Must be able to design, estimate and construct rolling mills and furnaces, engines, mining and hydraulic machinery, heavy gearing and general heavy machinery. The right man will find this a good opportunity for advancement. State age, experience, and salary expected, and send copies of references. Address Box 37, AM. MACHINIST.

✣ MISCELLANEOUS WANTS ✣

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d-h'd Lathes & Drills. S. M. York, Clev'd, O.

Koopman's Scales for quick measurements.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, Ohio.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Turned and Highly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

Wanted—Customers for our new Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

2nd-hand machinery, in good order; very cheap. Maslins, 165 First street, Jersey City, N. J.

See advertisement "Machine Tools for Sale" in Business Specials column. Logan Machine Works, Oil City, Pa.

Wanted—By two practical pattern makers, a location to start a pattern shop. Prefer power furnished. Address Box 34, AMERICAN MACHINIST.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

Wanted—Second-hand cutting off machine (small size) in fair order. Give size, condition, maker's name, and price. Address Moseley & Co., Elgin, Ill.

Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

For Sale—Valuable patent on a new double-action ratchet wrench, just patented. Would also go in machine shop for small wages to learn trade. C. C. Augustine, 408 Second st., Muscatine, Iowa.

For Sale or Lease—A manufacturing block, 40,000 feet floor space; 150 horse-power engine, shafting and elevators, in the center of this city. Railroad track in rear, surrounded by depots, good yard room. Will divide premises if desired, or will take an interest in an established business that could occupy same. Address The Brightman Machine Co., Cleveland, Ohio.

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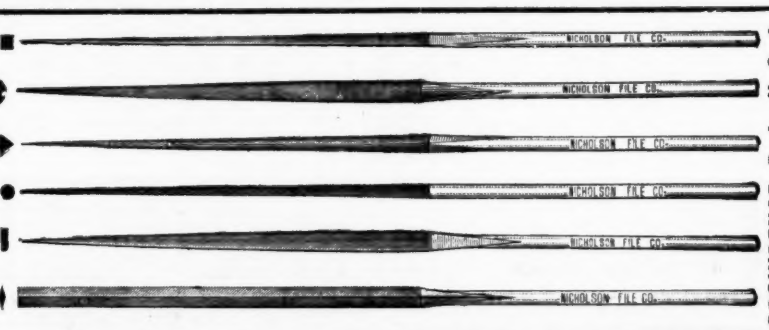

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11	1 3 4	1.10
12	2	1.20
13	2 1-4	1.35
14	2 1-2	1.45
15	3	1.60
16	3 1-2	1.80
17	4	2.10
18	4 1-2	2.75
19	5	3.25
Full set of 19		$23.60
20 (ext.)	5 1-2	4.00
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This Dog has a Very Heavy Point, so that if the thread wears a Heavier Screw can be substituted.

When ordering, state as above, whether a full set or a set of ½, or small set of 8. These dogs prefer them to any other make.

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With Steel Screws, Lathe Made and Hardened.

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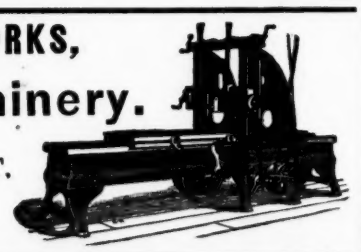

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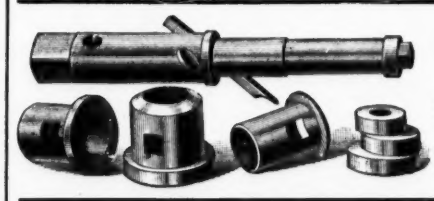

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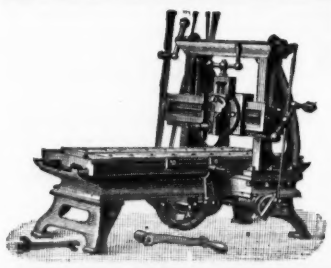

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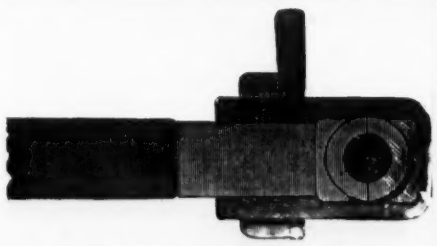

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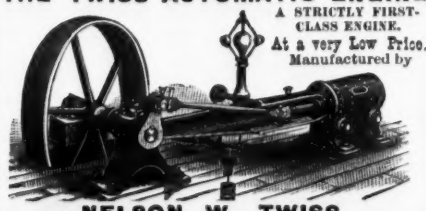

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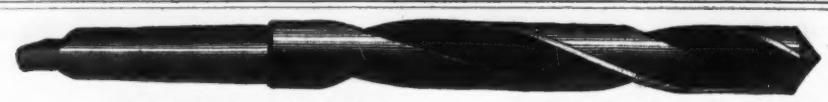

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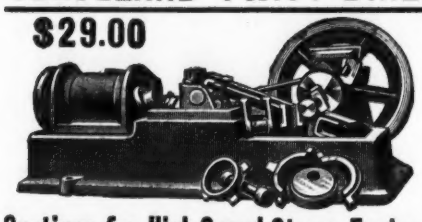

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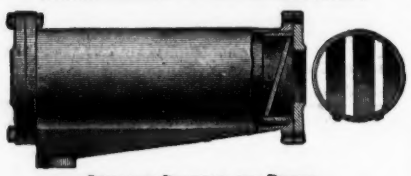

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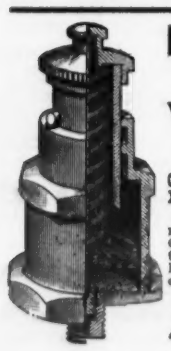

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Pattern Making, Various Articles on. By F. W. Barrows. Appearing in 29 issues.
Foundry Practice, Various Articles on. By Robt. E. Masters, appearing in 16 issues.
Strength of Different Mixtures of Cast-iron and Method of Testing. By Robt. E. Masters, April 24.
Foundry Practice, Articles on. By Foundryman. [L. C. Jewett.] Aug. 14, Sept. 25, Dec. 18.
Foundry Practice, Articles on. By S. Bolland, May 8, 22, 29, June 26, July 10.
The Morton-Poole Roll Grinding Lathe. By Joshua Rose, J. G. Tramis, Geo. H. Babcock and C. A. Smith, July 3, 24, Aug. 7, 14, 21, Sept. 25.
Machine Shop Cost and Time Accounts. By A. J. Shaw, Henry Metcalfe and C. A. Burton, April 3, 17, May 8.
Tests of Iron. By David Spence, April 17, Oct. 30.
Traction on Grades. By A. B. Ropes, Oct. 30.
Wilson's Valve Gear for Locomotives, Oct. 30.
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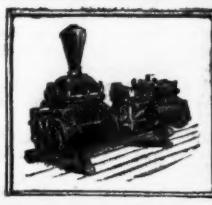

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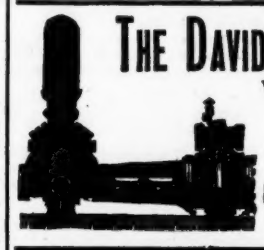

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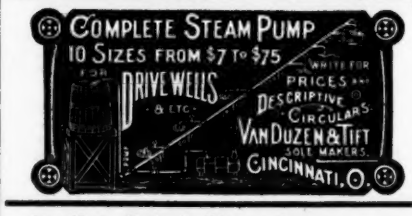

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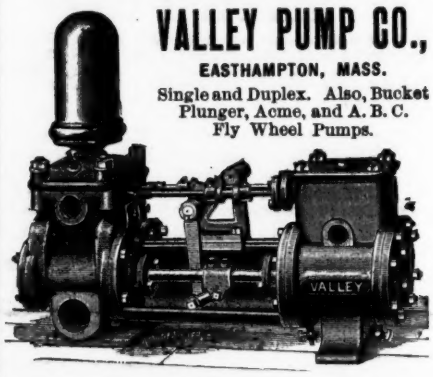

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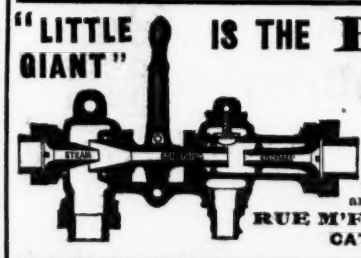

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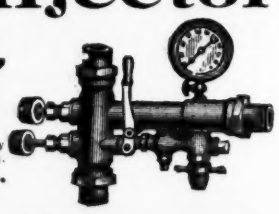

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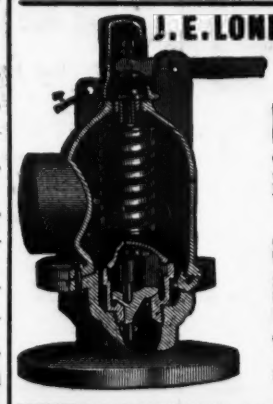

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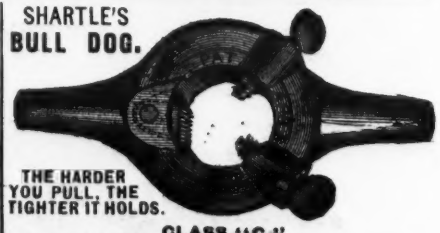

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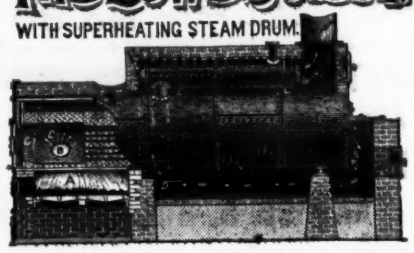

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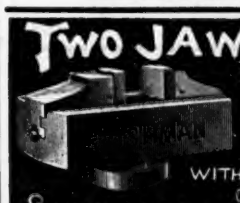

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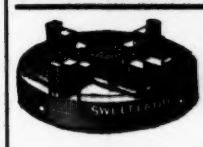

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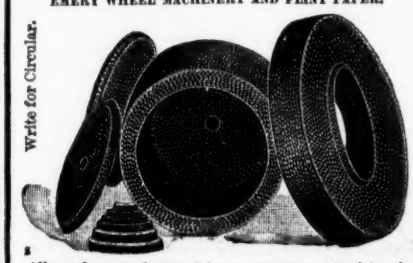

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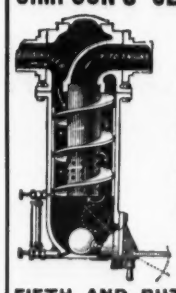

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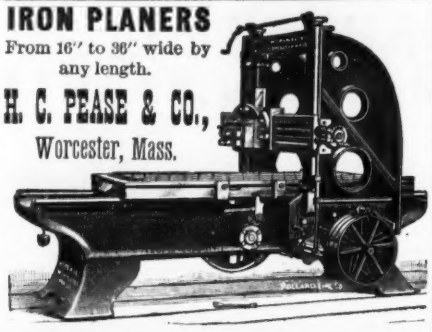

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All Sizes from 16 in.x16 in.x4 ft. to 36 in. x36 in.x12 ft. inclusive carried in stock.
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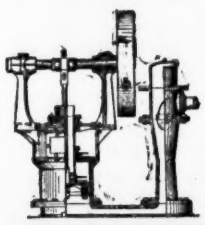

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CONSULTING AND MECHANICAL ENGINEERS
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No Air Locks 15 to 50 per cent fuel saved or equal amount of power gained. Runs with same economy as engine.
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(Formerly of Beaudry's Upright Power Hammer,)
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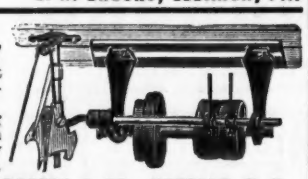

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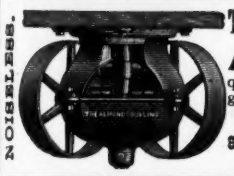

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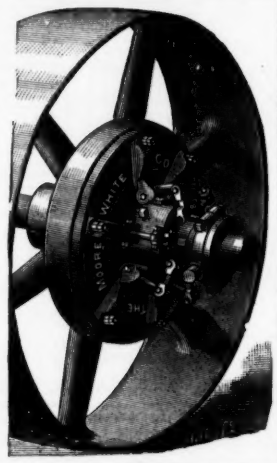

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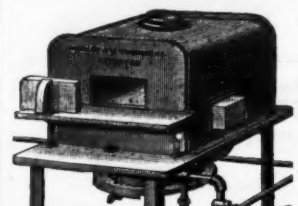

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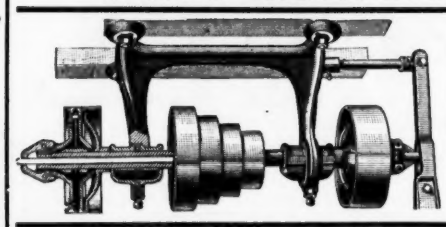

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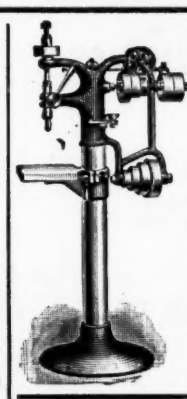

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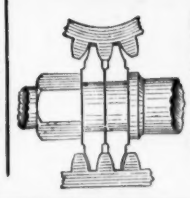

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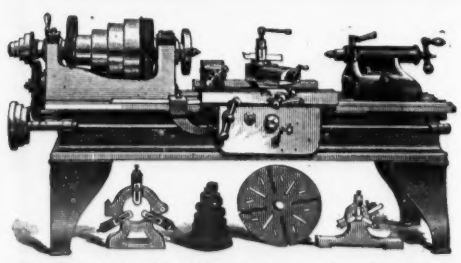
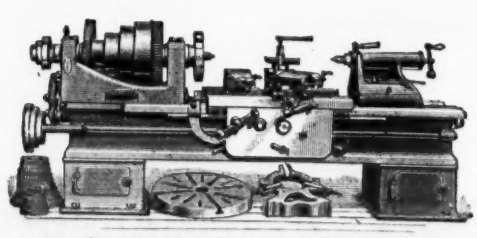
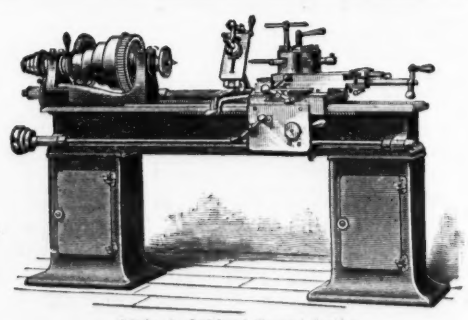


17, 19 and 21-inch Swing Large Hollow Spindle.



24, 27, 32 and 38-inch Swing, Cabinet Legs.
Taper Attachment, Automatic Stop, Compound Rest, Lead Screw under front V. All feeds reversed in apron. Extra heavy, Convenient, and easily handled.



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Taper Attachment, Automatic Feed, Lever and Screw Movement, most complete brass lathe on the market.
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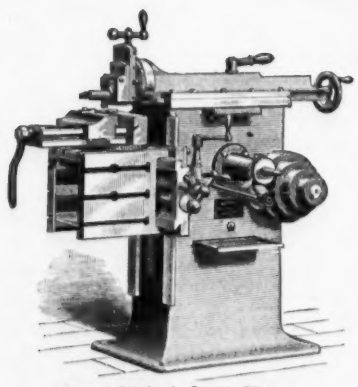

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TURRET LATHES
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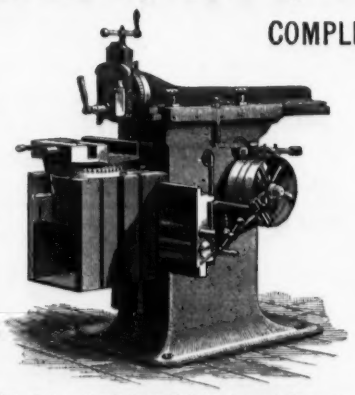
15 and 20-inch Crank Shaper.
Stroke changed and adjusted while running. Stroke at all times positive. Invariably plane to a line. Detachable Tables.



20, 26 and 32-inch Triple Geared Shapers.
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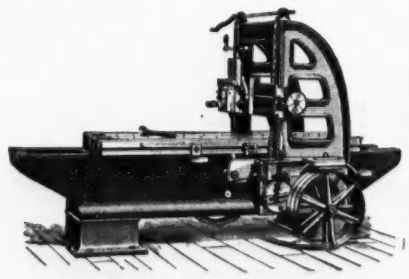

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Improved Device for holding Planer Bolts.

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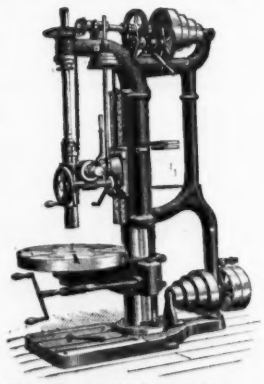

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Automatic stop to feed. Quick return on right side. Table operated from front. Large cones and long belts.

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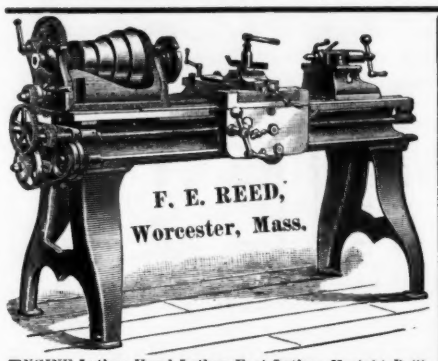

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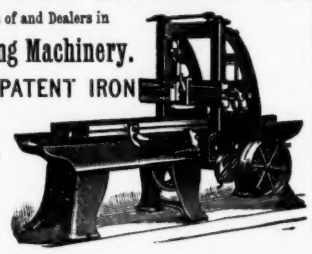

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HAS THESE GREAT ADVANTAGES:
The speed can be instantly changed from 0 to 1600 without stopping or shifting belts. Power applied can be graduated to drive with equal safety, the smallest or largest drills within its range, a wonderful economy in time and great saving in drill breakage. Send for catalogue.
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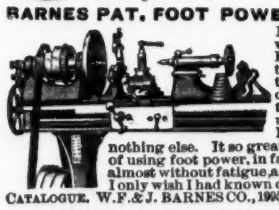

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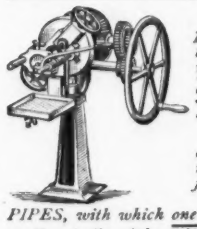

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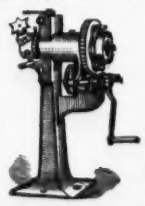

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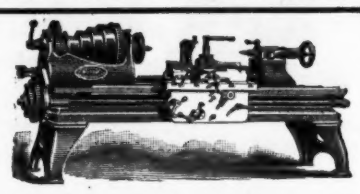

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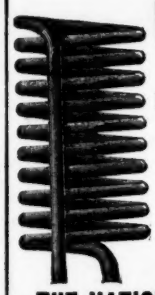

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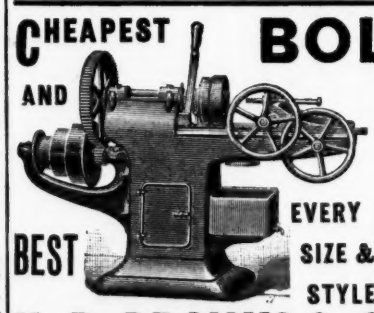

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We Invite Comparison for Accuracy with all others.
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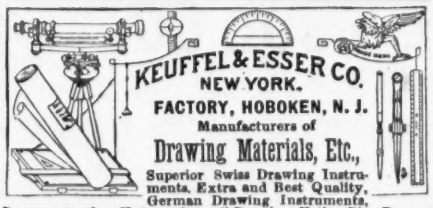

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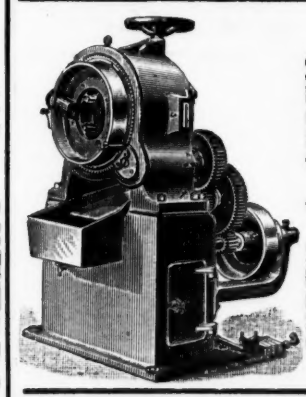

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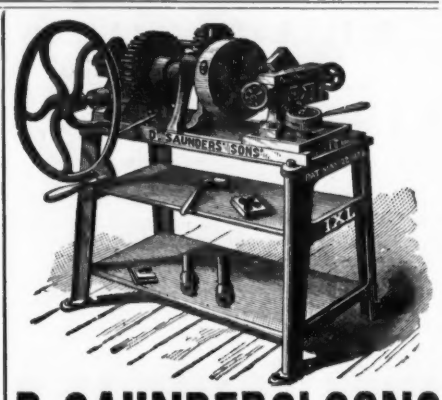

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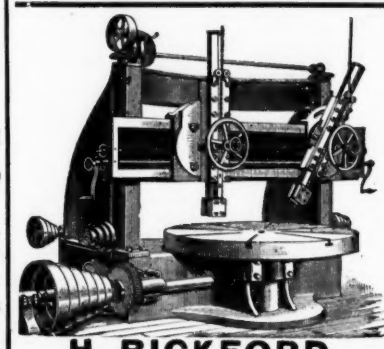

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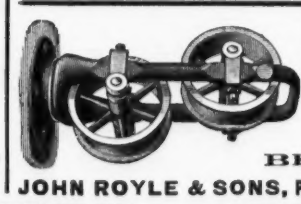

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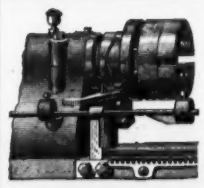

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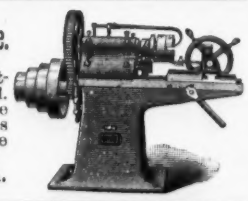

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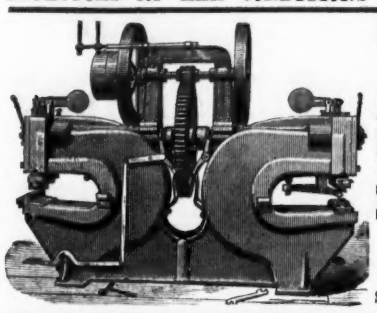

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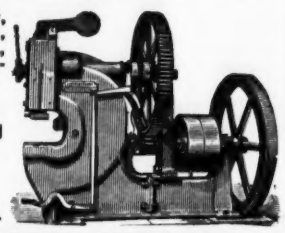

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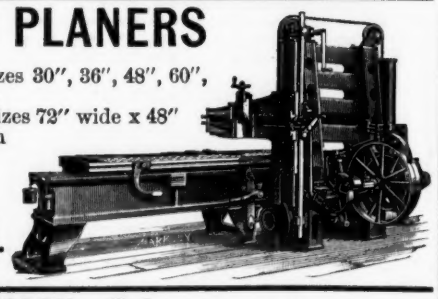

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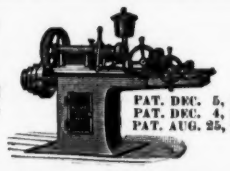

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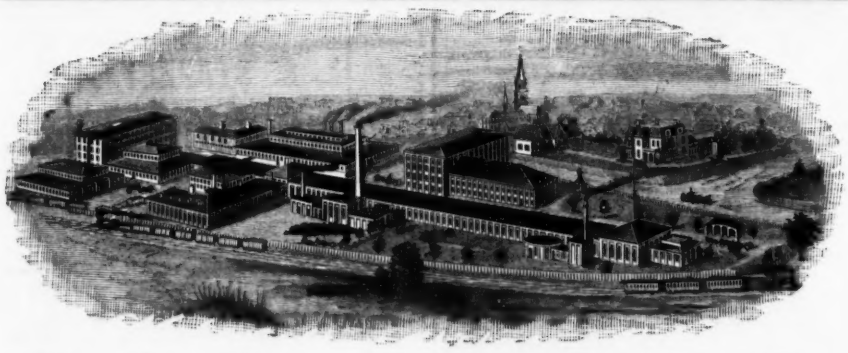

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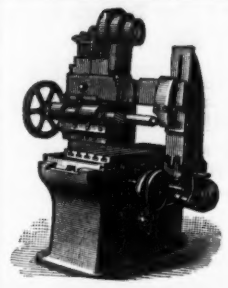

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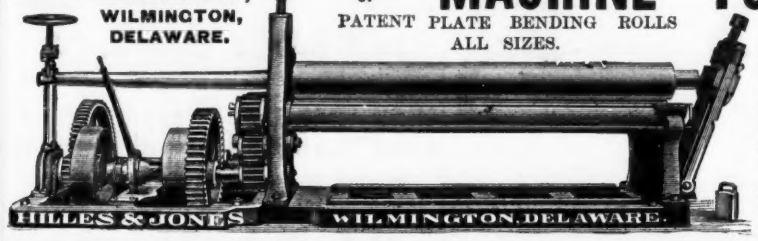

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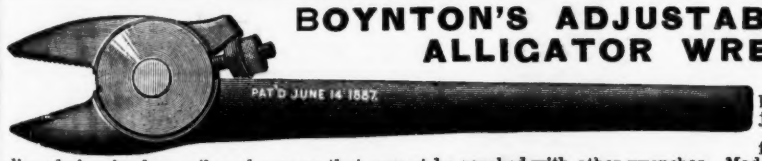

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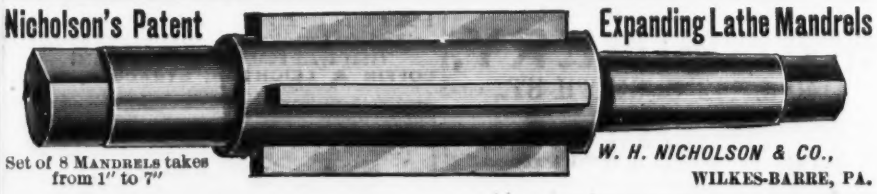

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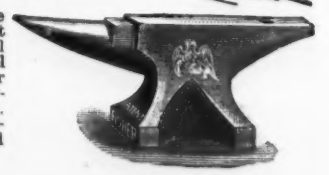

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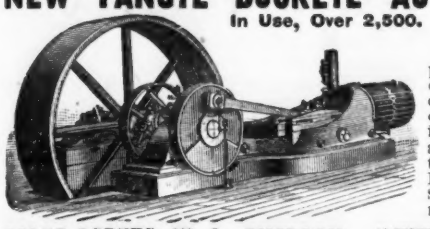

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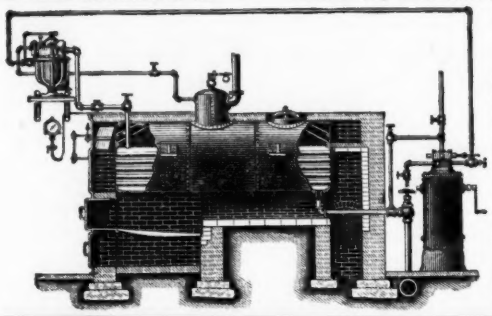

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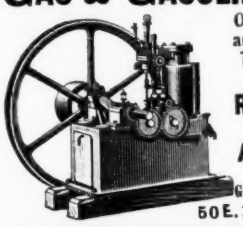

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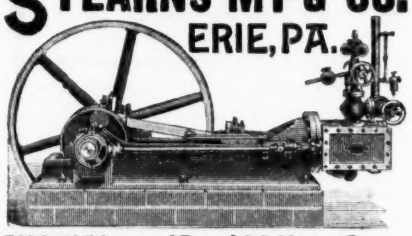

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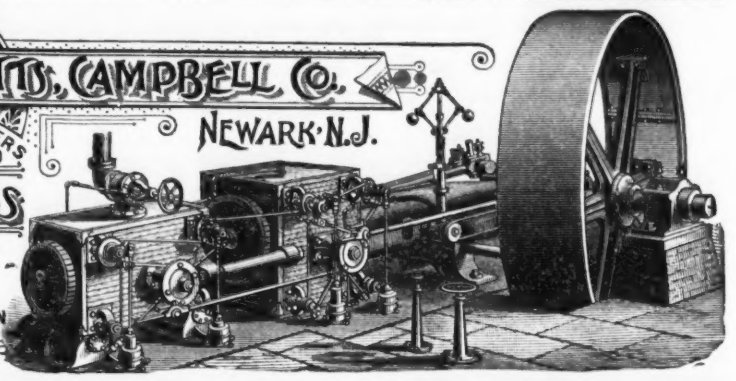

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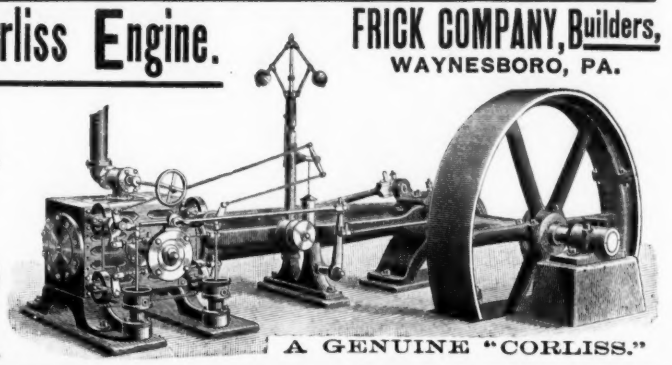

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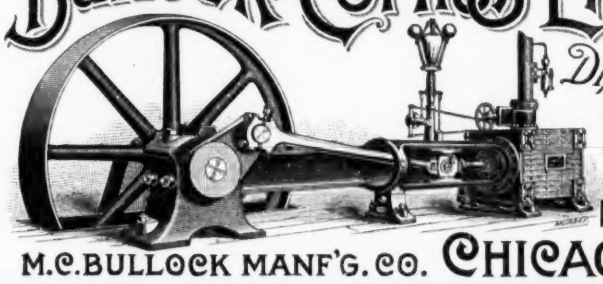

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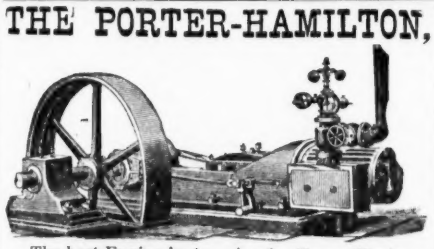

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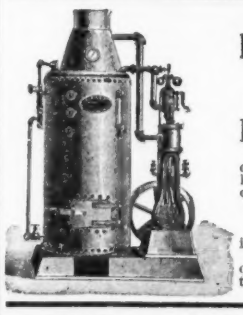

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If you want one Engine, it will pay you to write us.

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MINER & PECK MFG. CO.,

W. W. MINER, G. W. PECK, S. PECK, Proprietors.

Successors to

BEECHER & PECK,

Sole Manufacturers of

THE PECK PATENT DROP PRESS.

NEW HAVEN, CONN.

FOR SALE. CORLISS ENGINES.

The Fishkill Landing Machine Co., located at **Fishkill, on the Hudson, N. Y.,** offer to manufacturers and others desiring a well-built, economical and durable engine, their improved **CORLISS ENGINES.** They are endorsed by many reputable engineers and persons using them. Address as above.

STOP THAT NOISE
USE THE NOISELESS PATENT
TRADE MARK
RAW HIDE GEAR
COMPLETE IN ITSELF
NO METAL REQUIRED
MANUFACTURED BY THE NEW PROCESS RAW HIDE CO.
SYRACUSE, N.Y.

C. H. DE LAMATER & CO.

have closed their extensive manufactory at the **Foot of West 13th Street, New York,** and have sold the Hot Air Pumping Engine and Steam Pump business to the De Lamater Iron Works (incorporated in 1889), and the Propeller Wheel business to the Samuel L. Moore & Sons Co., of Elizabethport, New Jersey.

In order to close out the remainder of the stock, offer for sale

A Very Desirable Lot of Machinery,

such as lathes from 15″ to 88″ swing, planing machines 48″x45″x10′, 53″x50″x12′, 17″x14″x24′, 72″x69″x24′, and various other sizes; drilling machines, slotting machines, shaping machines, boring machines, bolt-cutting machines, cutting-off machines, nut tappers, milling machines, gear cutters, emery tool grinders, portable drills, screw-cutting machines, vises, lathe and planer tools, and a variety of small tools; also traveling and jib cranes.

Punching and shearing machines, for boiler makers, with a general outfit of small tools. Blacksmiths' tools, such as anvils, sledges, tongs, etc. Pattern lathes, benches, saws, screws, nails and a general supply of small tools. Foundry cranes, cupolas and small tools. Blocks, ropes, bolts, nuts, washers, packings, pipe and fittings, iron and brass valves. Boiler iron, steel plate and boiler rivets. Bar iron and steel, also steam hammers, and two 8″x16″ and one 10″x20″ Rider cut-off engines.

BALL AUTOMATIC CUT-OFF ENGINES,

ERIE, PA.

The characteristics of these Engines are Beauty of Design, Superior Finish, Limited Feet in Space required, Economy of Fuel, Perfection of Regulation.

CHARLES R. VINCENT & CO.,

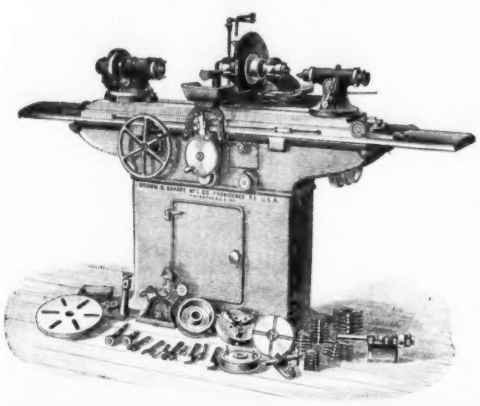
NEW YORK SELLING OFFICE, 15 CORTLANDT STREET.

BROWN & SHARPE MFG. CO., Providence, R. I., U. S. A.

"THE BEST HAS BEEN IMPROVED."

NO. 2 UNIVERSAL GRINDING MACHINE, IMPROVED.

Patented Feb. 27, 1877. Other Patents pending.



This machine is heavier, more rigid and of slightly greater capacity than the No. 2 Universal Grinding Machine. The bearing surfaces are larger, the reversing mechanism improved, and the cross-feed arranged for finer adjustments.

The machine is more powerful, and the overhead works provided for a wider range of speeds of wheel and work. It is specially adapted for circular grinding where accuracy and uniformity are required, and it is used in the manufacture of spindles, boxes, arbors, jewelers' rolls and standard plugs and rings. It will grind straight or taper pieces, either inside or outside, and any angle, obtuse or acute, can be readily produced.

Western Representative,

S. A. SMITH,

23 South Canal St., Chicago, Ill.

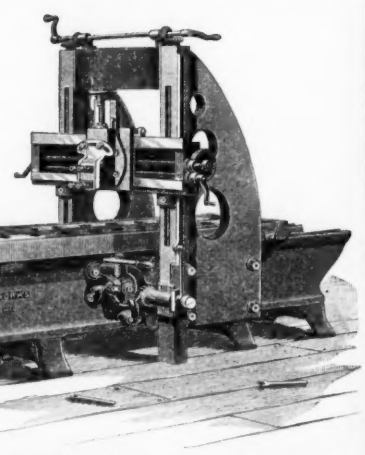
NILES TOOL WORKS,

HAMILTON, OHIO,

PLANERS A SPECIALTY.

New Patterns 1889.

Strictly first class. Moderate prices. Perfection of workmanship. Positive feed. Quick return. Extra heavy. Large bearings. The smoothest running Planers.



NEW YORK, 98 Liberty St. **PHILADELPHIA,** 705 Arch St. **PITTSBURCH,** Lewis Block. **CHICAGO,** Phenix Building.

CRANES

THE YALE & TOWNE MFG CO.,
STAMFORD CONN
NEW YORK CHICAGO PHILA BOSTON

JENKINS BROS.' VALVES.

Every valve tested and warranted, all parts interchangeable.
Nothing but best Steam Metal used in the manufacture.
JENKINS Eyed Stuffing Box and Disc Removing Lock Nut
Is used only in the Jenkins Bros.' Valves.
None are genuine unless stamped with "Trade Mark."
Should you order INSIST on having Jenkins Bros.' Valves.

71 JOHN STREET, NEW YORK. *54 DEARBORN STREET, CHICAGO.*
21 NORTH FIFTH STREET, PHILA. *105 MILK STREET, BOSTON.*

FOR IMMEDIATE DELIVERY.

3 BACK GEARED MILLING MACHINES.
4 18 x 6 CABINET TURRET LATHES.
3 15 in. CRANK SHAPERS.
2 20 in. GEARED SHAPERS.
2 24 x 24 x 6 IRON PLANERS.
5 12 in. HAND LATHES.
4 12 & 15 in. TURRET BORING LATHES.
☞ ALL MACHINES OF OUR LATEST DESIGNS.

THE LODGE & DAVIS MACHINE TOOL CO.,

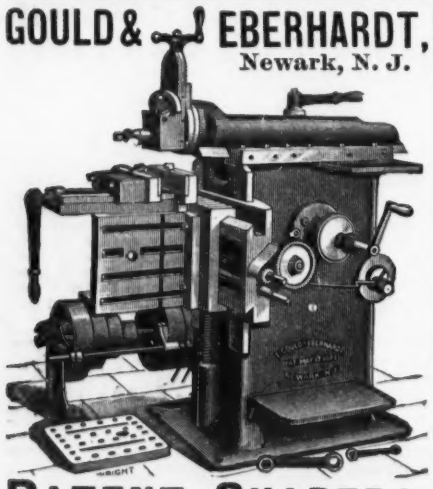
WORKS: CINCINNATI, O.

EASTERN HOUSE, 64 CORTLANDT ST., NEW YORK.
WESTERN HOUSE, 68 & 70 S. CANAL ST., CHICAGO.

☞ *SEE ADVERTISEMENT PAGE 16.*

GOULD & EBERHARDT,

Newark, N. J.



PATENT SHAPERS.

Sizes, 12", 16", 24", 26", 30" in stock.

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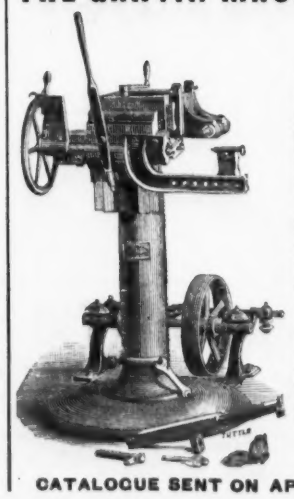
THE GARVIN MACHINE CO.

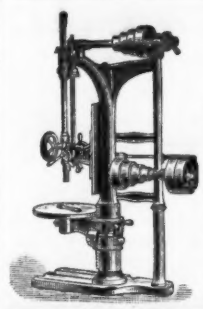


SMALL GEAR CUTTER.

This handy little machine is intended for rapid and convenient cutting of light gears, ratchets, etc., used in telegraphic and mathematical instruments, etc.

GEAR AND RACK CUTTING A SPECIALTY.
MANUFACTURERS AND DEALERS IN IRON-WORKING MACHINERY.
LAIGHT & CANAL STS., N. Y. CITY.

CATALOGUE SENT ON APPLICATION.



THE PRATT & WHITNEY CO.,

Hartford, Conn.,

MANUFACTURE

Renshaw's Ratchet Drills, Nos. 1 and 3; **Upright Self-Feeding Hand Drilling Machines** for Blacksmiths; **Upright Drilling Machines,** single and multi-spindle, both those in which the spindles are without feed movement and tables are operated by hand or foot lever, and those in which the tables have provision for adjustment, and spindles are fed by hand lever, or by hand wheel, or automatically; also, **Horizontal Drilling Machines,** single and multi-spindle.

WESTERN BRANCH, 100 West Washington St., Chicago, Ills.

THE BILLINGS & SPENCER CO.,

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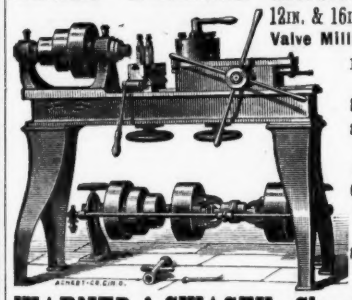
Manufacturers of

BILLINGS' PATENT CUTTING-OFF TOOL.

The Holder is drop forged, of steel, and finished in a thorough manner. The Cutters are made of the best tool steel and furnished in the following thicknesses: $\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$, $\frac{7}{32}$, $\frac{1}{4}$.

Drop Forgings of Bronze, Copper, Steel and Iron of all descriptions.

BRASS WORKING MACHINERY.



12IN. & 16IN. MONITORS
Valve Milling Mach's
Double Key Lathes,
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Small Tools and Fixtures.

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Manufacturer of ENGINE LATHES from 16 to 48 in. swing. Lots, Photographs and Prices furnished on application.

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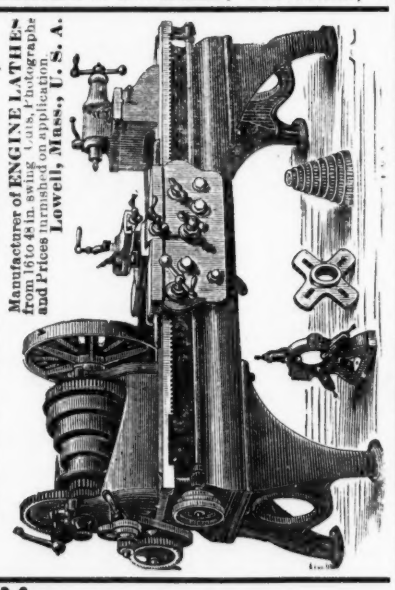

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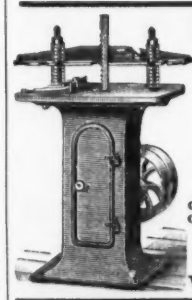

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A SPECIALTY.
SEND FOR LIST OF

New and Second-Hand

Lathes, Planers, Drills, or anything in Machinists' Tools or Supplies.

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BORING MILLS.

Radial Drills, Planers, Lathes, Heavy and Powerful, from new patterns of the latest and best designs.

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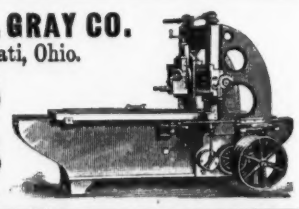

STEEL CASTINGS.

PRATT & LETCHWORTH,
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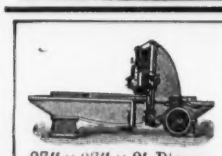
BUFFALO STEEL FOUNDRY,
BUFFALO, N. Y.



27" × 27" × 8' Planer.

20" × 6' Chucking Lathe.

16" × 6' Engine Lathe.

25" Pillar Shaper.

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